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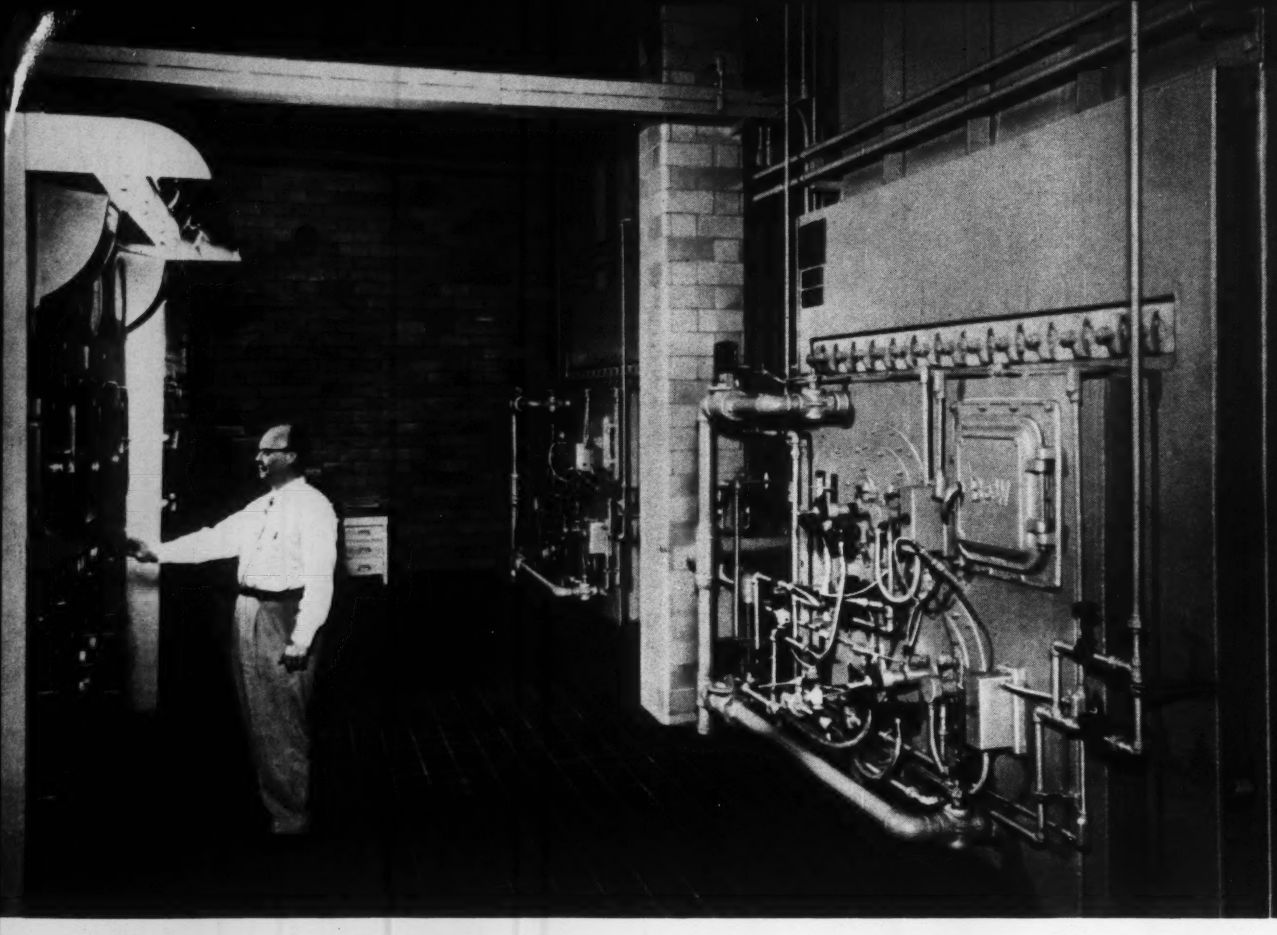
ASME SEMI-ANNUAL MEETING
St. Louis, Mo. June 14-18

Forged Beryllium For Space Flight



Hospitals Turn to B&W Integral-Furnace Boilers for Reliable Supply of Clean, Dry Steam

Every day, year after year, even the routine activities of a hospital are vital. The continuous, reliable services expected from hospitals must be matched by the equipment upon which they depend.

Institutions like St. Mary's Memorial Hospital at Knoxville, Tenn., have come to depend upon the reliability and continuity of operation offered by B&W Integral-Furnace Boilers. Cleanliness of operation, high fuel economies, and maximum capacity in small boiler room space are other benefits of these units which appeal to health and budget-conscious hospital management.

Modern, efficient steam supply with ample capacity for future needs, which include a new 105-bed wing and 150-bed nurses' residence with classrooms and auditorium, are being provided at St. Mary's Hospital by two new B&W Boilers.

Flexibility of the B&W Integral-Furnace design is another of the many reasons why St. Mary's and scores of other hospitals throughout the country have selected B&W. The new boiler at Knoxville is oil and gas-fired, with provision made for the installation of a stoker for future coal firing.

Rapid response to steam demands, dependable supply of clean, dry steam, and the ready availability of a nation-wide service staff, have given B&W Boilers preference among those who specify and buy for hospitals and institutions throughout the nation.

B&W provides a single responsibility in design, engineering, manufacturing, installation, and service through a national network of plants and engineers.

The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

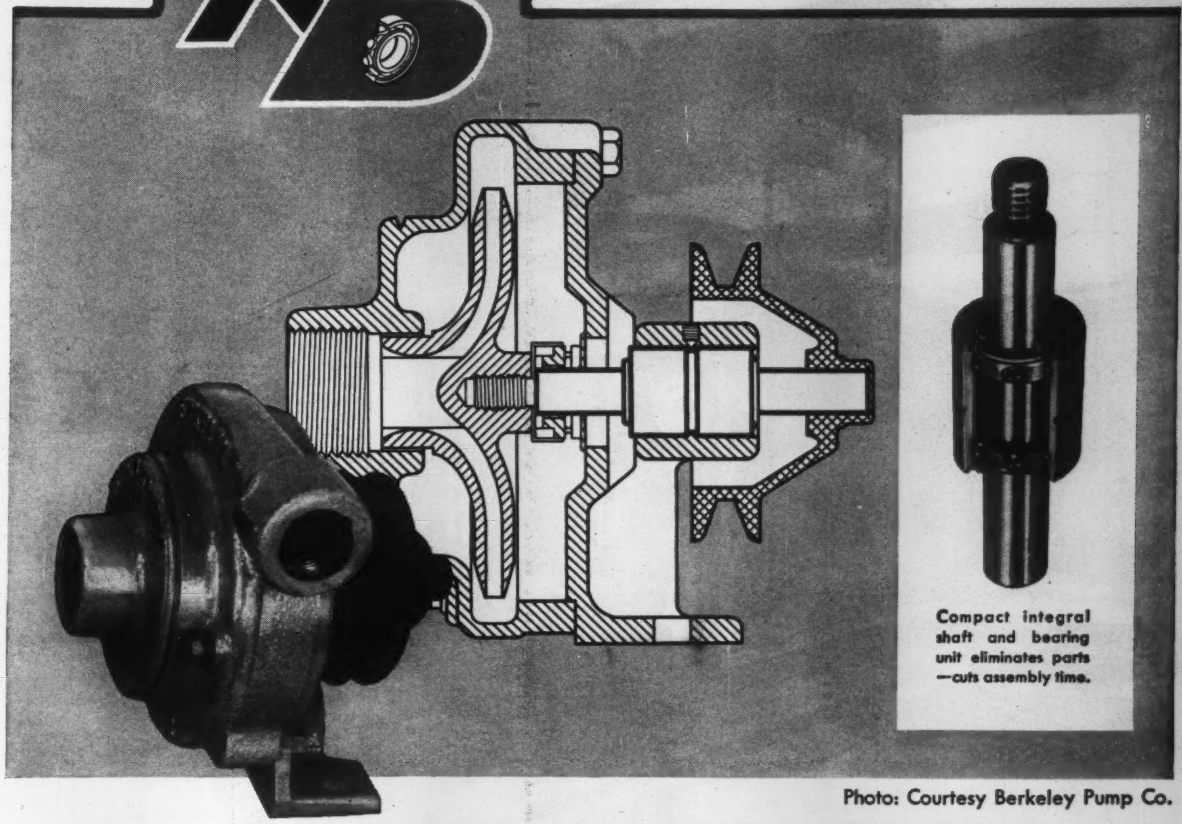
Two B&W Integral-Furnace Boilers at St. Mary'
Hospital have capacity of 30,000 lb. of stea
per hour each at operating pressure of 110 psi
Design pressure of 160 psi. Architect: David B
Liberman, Knoxville, Tenn. Consulting Engi
neer: Albert F. G. Bedinger, Knoxville, Tenn.

G-851-FF

BABCOCK & WILCOX

BOILER DIVISION

CASE HISTORIES



Compact integral shaft and bearing unit eliminates parts —cuts assembly time.

Photo: Courtesy Berkeley Pump Co.

Ball Bearings Help Cut Size... Lower Costs $2.50 Per Pump!

CUSTOMER PROBLEM:

Redesign utility water pump for Air Conditioner market. Conversion must achieve smaller size without reducing pump capacity. At the same time, customer must lower over-all production costs.

SOLUTION:

N/D Sales Engineer suggested the versatile New Departure fan and pumpshaft ball bearing. This compact precision bearing permitted use of over-the-housing pulleys with belt load located over the raceway. Its integral shaft, which is the inner race, simplified design and helped reduce housing size without changing pump capacity. In addition, the sealed and lubricated-for-life bearing replaced two sealed bearings, separate shaft and snap rings . . . cutting part and assembly-time costs $2.50 per pump.

Perhaps one of New Departure's wide selection of *production* ball bearings will help give *your* product the sales appeal and cost savings you're looking for. For more information, call the New Departure Sales Engineer in your area or write Dept. U-5.

Replacement ball bearings available through
United Motors System and its Independent Bearing Distributors

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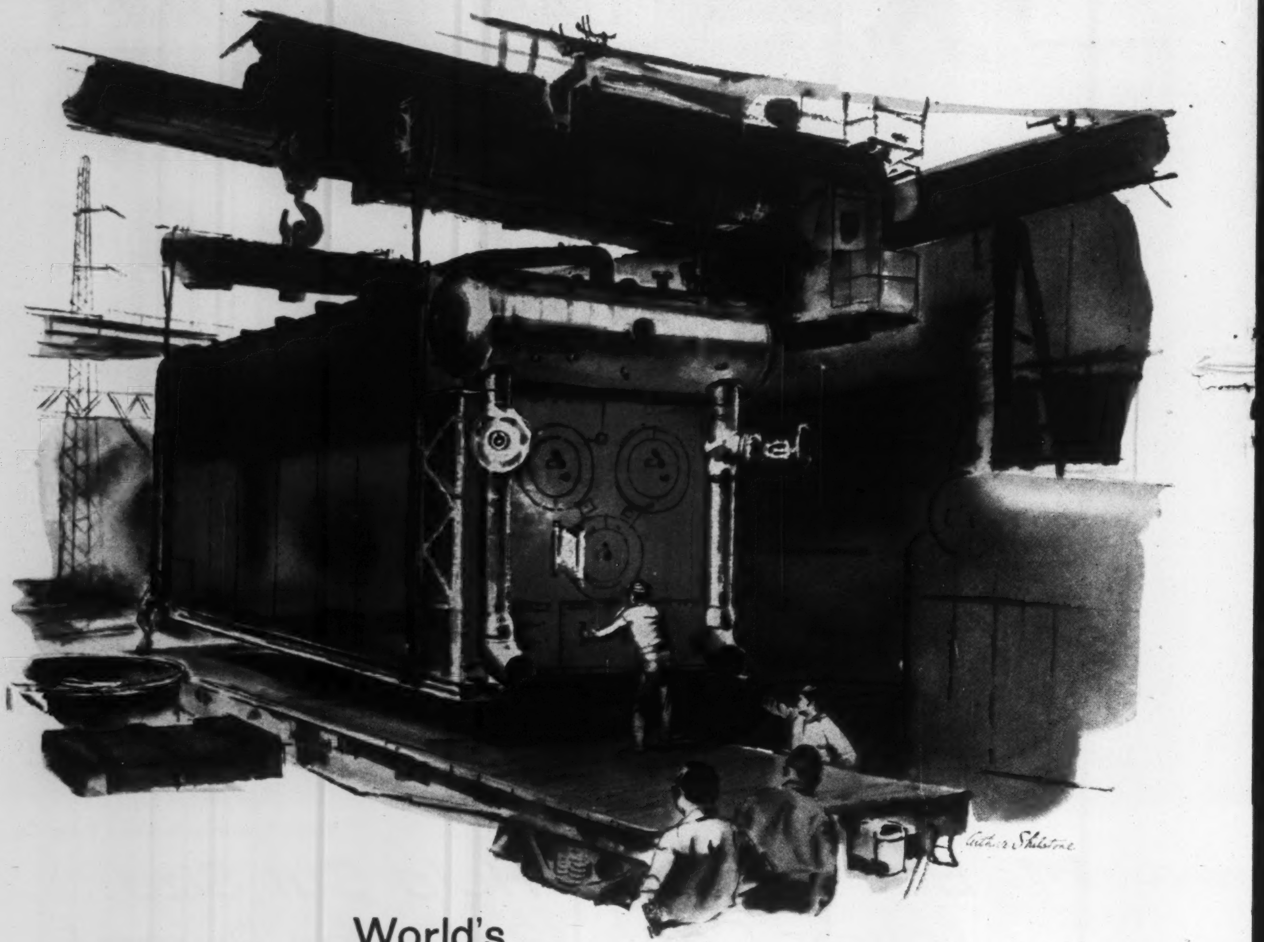
"CREATIVE ENGINEERING" PROVIDES NEW TYPE OF PACKAGE BOILER TO MEET TODAY'S STEAM NEEDS



World's highest capacity Package Boiler removes traditional space and performance limitations

The flat car pictured above is carrying an engineer's dream. It's a space-saving steam generator which makes electric utility performance standards available to industrial plants. It's a unit of large capacity—yet it's factory-assembled and ready to be installed as a one-piece "package." It's a product which reflects C-E's record of developing steam equipment that introduces new standards of performance.

For the first time, here's a package boiler capable of producing over 100,000 pounds of steam every hour . . . and at pressures and temperatures previously unobtainable in a 'packaged' unit. These results are made possible by utilizing *C-E Controlled Circulation*, the most notable development of this decade in the field of large utility boilers.

In short, here's a new alliance of performance with economy. This is what progressive management demands of its capital equipment. This is what you can count on *Combustion* to deliver.

"CREATIVE ENGINEERING" is the reason for the leadership attained by C-E products. The products which bear this mark of leadership include:

all types of steam generating, fuel burning and related equipment · nuclear power systems · paper mill equipment · pulverizers · flash drying systems · pressure vessels · soil pipe

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THE COVER

Beryllium skirt for a missile, formed in minutes on an 18,000-ton press at the Wyman-Gordon USAF plant, North Grafton, Mass. This is the first large beryllium part successfully forged. Light as magnesium, resistant to great heat, beryllium is the most difficult of the exotic metals to form. See" Briefing the Record."

A CHALLENGE TO ASME...**G. B. Warren** 40

Innovation used to depend upon chance, the inventor's inspiration. Now the "leap into the unknown" is a planned project. The ASME's President reviews the Society's role in the creative process.

GRAPHITIZATION FAILURES IN PIPING...**J. B. Nuchols and J. R. McGuffey** 43

They had used every precaution. Yet h-p steam piping, of carbon-molybdenum steel, failed at the Oak Ridge power plant. There are factors in graphitization not readily or surely predicted.

THREE MODELS FOR THREE RANGES...THE BOEING 707....**J. E. Steiner** 46

How can one transport be optimized for both long and short range? It can't. So you use different makes of planes—and maintenance costs go up. Here's an alternative: Boeing's "family" of planes.

"ZYTEL" SPUR GEARS..........................**K. W. Hall and H. H. Alvord** 50

Zytel 101: What will be the load-carrying capacity of gears cut from disks of this thermoplastic nylon resin? Du Pont sponsored this investigation carried out at the University of Michigan.

USING STATISTICS TO ANALYZE MATERIALS HANDLING PROBLEMS.............................**W. J. Richardson** 54

Rule of thumb, based on rough averaging, may serve your purposes. If not, you'd best become wise in the collection and handling of data. There are methods and devices. And there are pitfalls.

NUMERICAL CONTROL 56

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APT System...D. T. Ross
Organization..J. J. Childs
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Potentialities.....................................W. M. Stocker, Jr.
Air Force..W. M. Webster
APT Joint Effort...................................D. T. Ross

Ready to run production on part No. 9465? Go to the file, get out the tape for that part, put it in the "reader," and load the workpiece into the machine. Oh, one more thing: Press the button.

Contents continued on following page

How B&W JOB-MATCHED TUBING saves in oil heater applications

... A complete range of carbon, alloy and stainless steels—permits choice of steel to match service conditions.

... A wide size range—provides for freedom of design.

... Uniform dimensions and mechanical properties — helps to provide ease of fabrication.

These are just a few of the reasons it pays to specify B&W Job-Matched Seamless Pressure Tubing. Call the tubing specialist at your local B&W District Sales Office, or write for Bulletin TB-417 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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Power Plant Products

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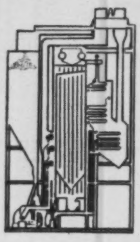
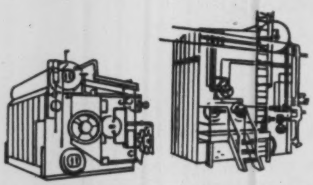


LARGE STEAM GENERATORS Designed to meet all requirements for Central Station or Industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.



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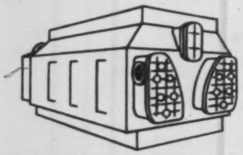
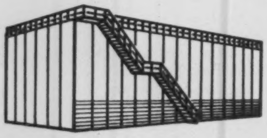
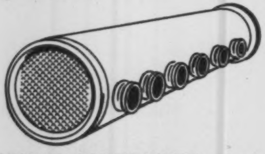


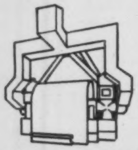
CONDENSERS and HEATERS—Condensers of single or two-pass, double or counter-flow designs. All-welded high and low pressure feed-water heaters.



COOLING TOWERS —Induced draft counter flow towers of all-redwood construction for maximum dependability and long service life.



NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.



PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

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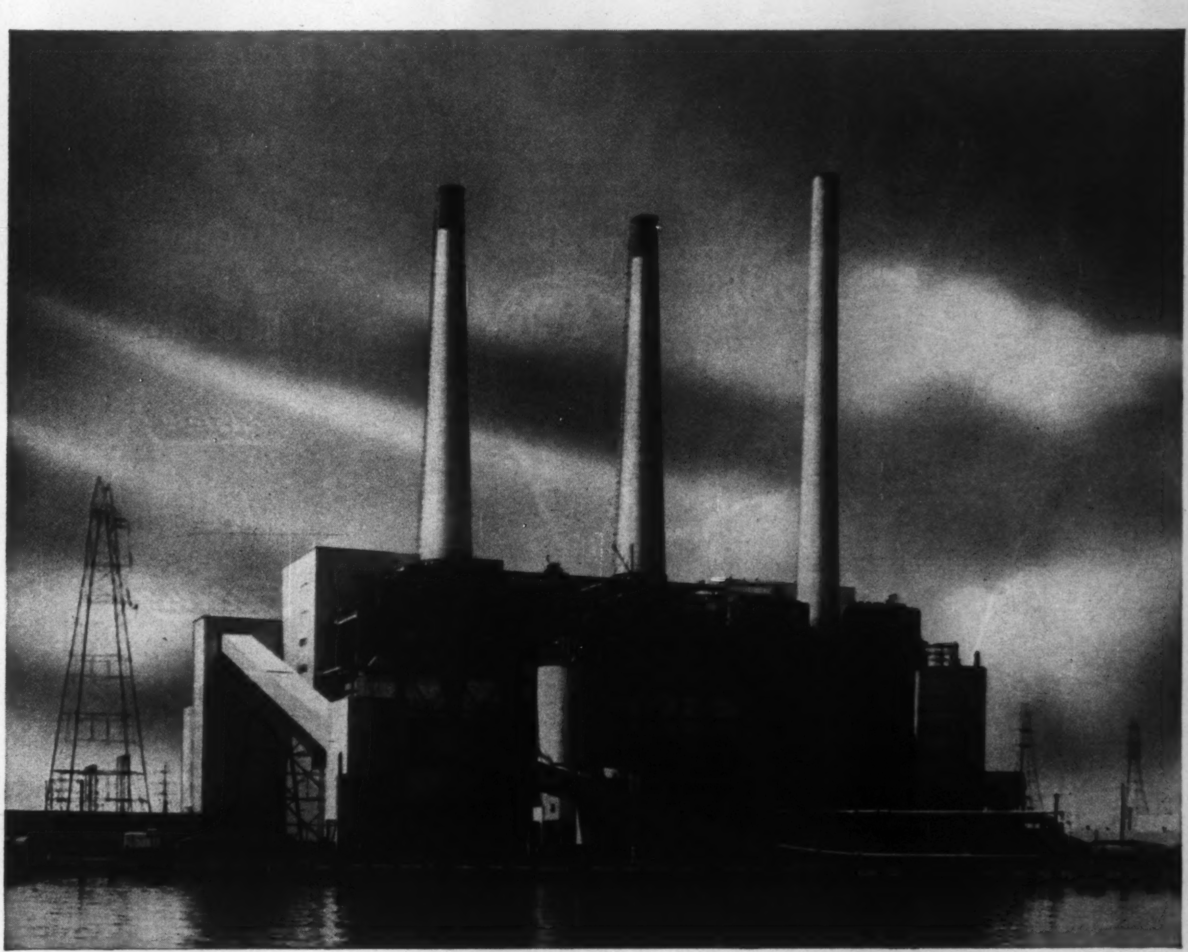

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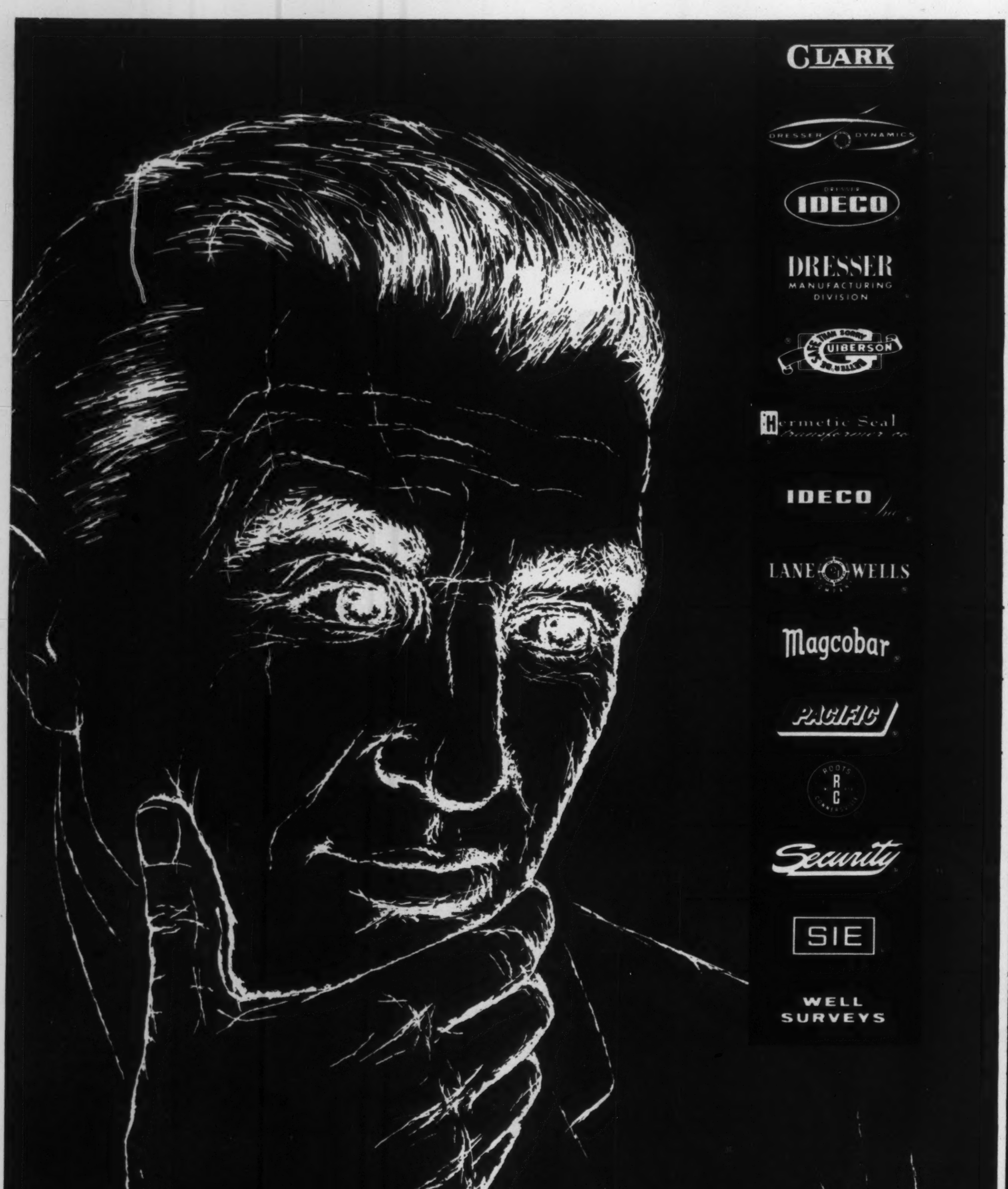
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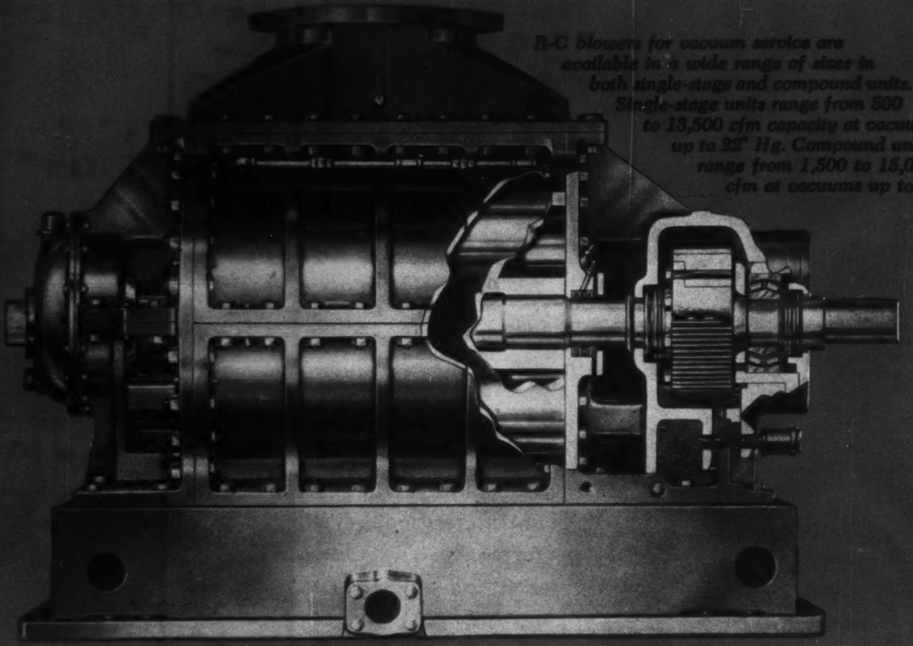

R-C blowers for vacuum service are available in a wide range of sizes in both single-stage and compound units. Single-stage units range from 500 to 13,500 cfm capacity at vacuums up to 22" Hg. Compound units range from 1,500 to 15,000 cfm at vacuums up to 27" Hg.

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R-C blowers for vacuum service are used throughout the world in a large number of industries. In chemical processing, R-C blowers have many applications in the handling of nitrogen, hydrogen, acetylene, moist air with SO^2, and other oil and gas mixtures. In paper-making, R-C blowers supply vacuum for suction rolls. In mining, R-C blowers provide vacuum for flotation, filtration and other ore processing requirements. And throughout general industry, they are used for carburetor testing, pneumatic conveying, food processing, cigarette tipping machines, aircraft component testing and many other applications.

Only Roots-Connersville vacuum equipment offers so many advantages – exclusive rotary positive design, ease of installation, efficiency of operation, and long years of trouble-free service. These features are the result of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.

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CYCLOIDAL
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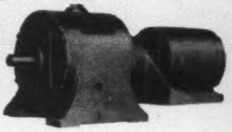
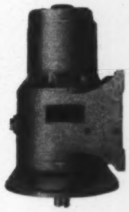


all-motor horizontal gearmotor

all-motor right angle gearmotor



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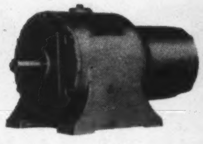
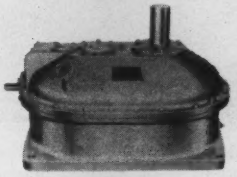
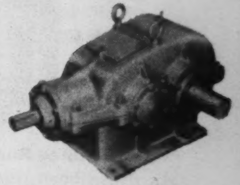


integral horizontal gearmotor

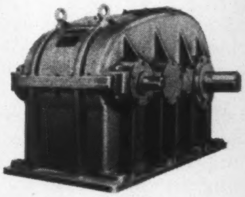
keep down-time down . . .



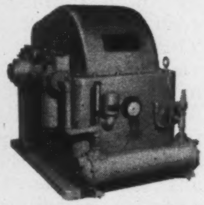
large right angle vertical speed reducer



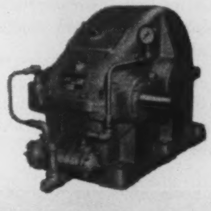
large right angle horizontal speed reducer



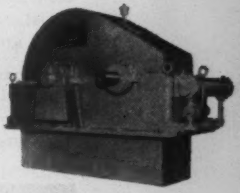
parallel shaft speed reducer



small high speed unit



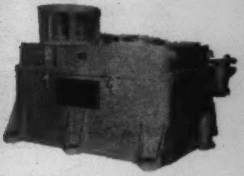
medium speed unit



large high speed unit

with **WESTERN GEAR** ***SPEEDMASTER***

FULL LINE POWER TRANSMISSION EQUIPMENT



vertical speed reducer

Years of experience with user problems have been translated into superior designs that provide practical benefits. Greater reliability, increased production, lowest maintenance cost, no-cost engineering assistance . . . all benefits save you time and money.

Western Gear offers a complete line of gear drives in various shaft arrangements and ratios up to 10,000 HP for most industrial applications. Many special designs beyond our catalog range.

INDUSTRIAL PRODUCTS DIVISION

WESTERN GEAR CORPORATION Industrial Products Division P.O. Box 126, Belmont, Calif.

name & title ____________________

company ____________________

address ____________________

city ____________ *state* ____________

Please send me:

☐ *Gearmotors Bulletin 5806*

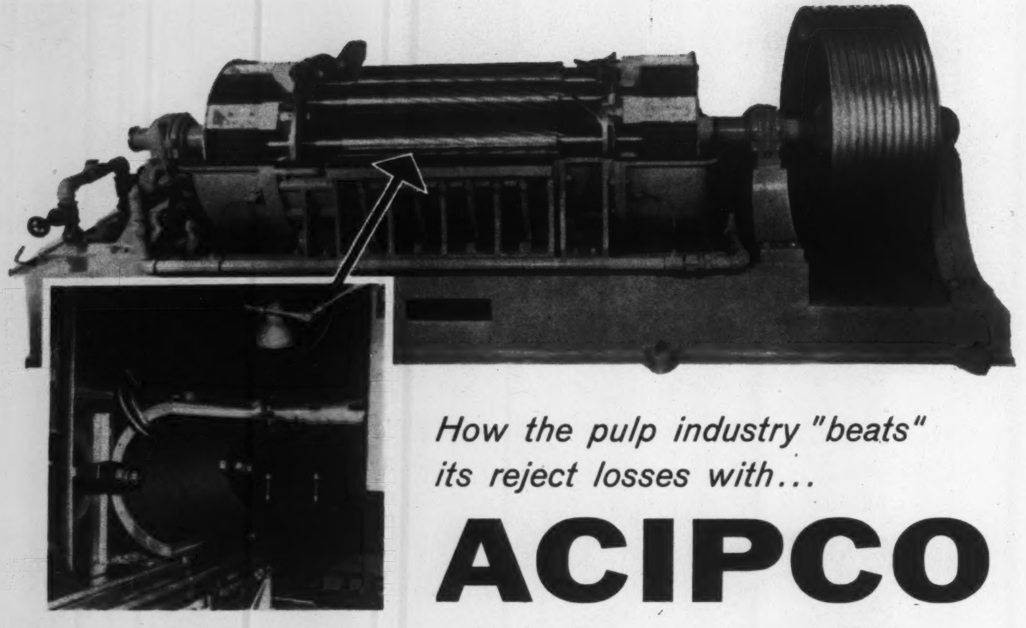
☐ *Parallel Shaft Speed Reducers Bulletin 5802*

☐ *StraitLine Speed Reducers Bulletin 5816*

☐ *Vertical Speed Reducers Bulletin 5908*

☐ *High Speed Unit Bulletin 5904*

5907



How the pulp industry "beats" its reject losses with...

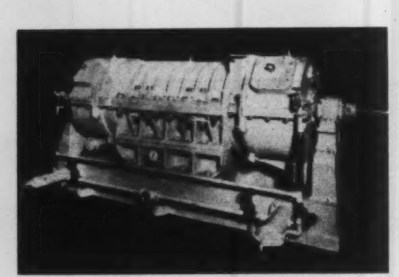
ACIPCO

stainless steel liners

Size Range Lengths up to 410" have been produced to meet modern machinery requirements. OD's from 2.25" to 50"; wall thicknesses from .25" to 4"

Analyses All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

Finished As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.



Reject recovery with Anton J. Haug refiners is saving paper mills more than $7 million per year in wood alone! ACIPCO *furnishes tough, durable, stainless steel liners which go inside the main casings of the machines.*

In Canada, Europe, South America, Japan—as well as in this nation's largest paper mills—refiners manufactured by Anton J. Haug are saving more than 700 tons of good groundwood, sulphite and kraft rejects *each day*. This refined stock is marketed at the same price as virgin pulp—and the annual savings in wood alone is more than $7 million!

ACIPCO plays an important part in reject recovery by furnishing the stainless steel lining which goes inside the main casing of the Haug refiner. The lining, statically cast to Haug's exacting specifications, fits inside a stationary cylindrical shell.

Stock, entering at one end, travels through the machine in a helical path and is *repeatedly subjected to the pressure of high speed rolls which crush it against the liners.*

In special shapes such as this, as well as centrifugally spun steel tubes, ACIPCO castings stand up . . . under the longest, toughest assignments. If *your* application is a special one, it will be worthwhile for you to investigate ACIPCO's facilities for casting, heat treating, machining, fabricating and testing.

Stainless steel, carbon steel, alloy iron or special analyses—versatile ACIPCO tubes are made to solve your specific tubular metal problem. Call ACIPCO today for complete information—or for expert technical assistance.

Special Products Division

AMERICAN

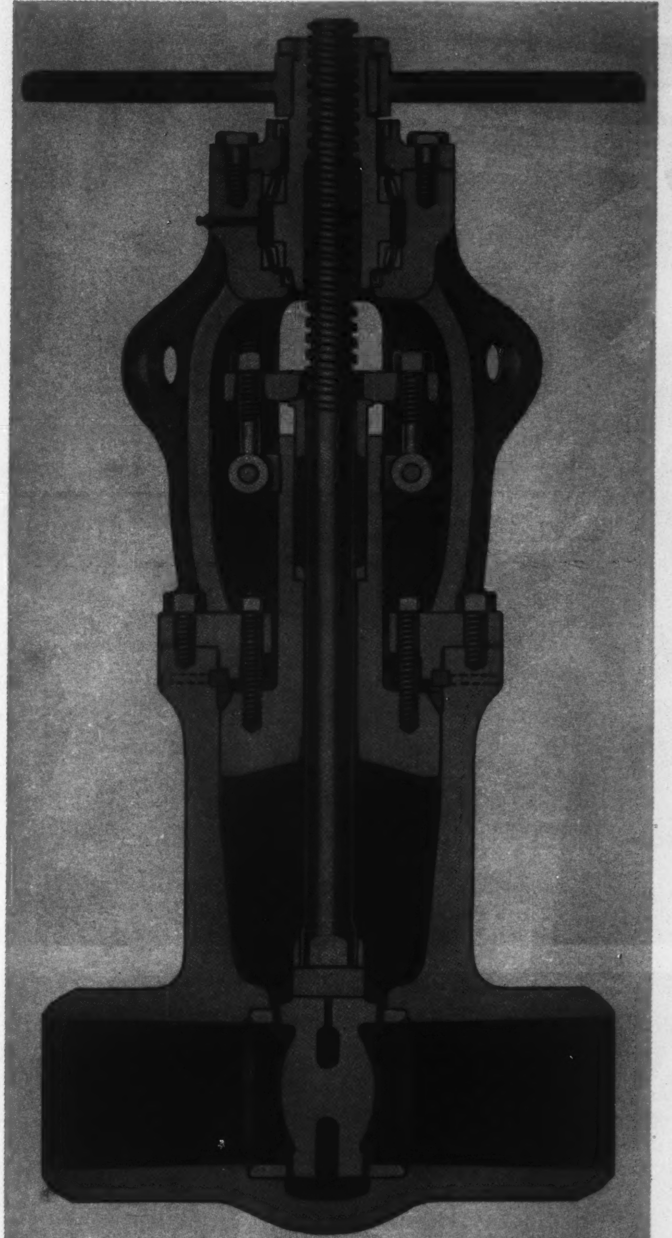
CAST IRON PIPE CO.

ACIPCO

ACIPCO

PHONE AL 1-8121, EXT. 285 • BIRMINGHAM, ALA.

Here's the Ultimate in the Control of High Pressures, Temperatures...



Sectional view of 1500-pound Steel Pressure Seal Gate Valve. 600, 900 and 2500-pound valves are also available—in all commercial sizes.

Steel Pressure Seal Globe, Angle, and Check Valves are also included in the complete Powell Line.

POWELL PRESSURE SEAL VALVES

When Powell Steel Pressure Seal Valves are specified and installed on high pressure, high temperature lines you can be sure of top performance in controlling the flow of the fluids being handled.

Superior features of design and construction, many found only in Powell Valves, make this possible. For example:

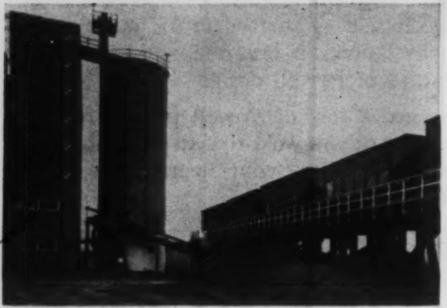
- Sturdy studs hold the yoke to the body, eliminating the need of a heavy clamp, and maintaining perfect alignment and rigidity of yoke to the body.
- Stellite faced pack-under-pressure seat and stem guide insure tight sealing and accurate guiding of stem.
- Lifting lugs in yoke facilitate handling the valve during erection and maintenance, and provide means for supporting weight of the valve.
- The gasket can be removed without damaging the sealing surface of the body. The gasket seating surface in the body can be easily lapped, if required—an outstanding feature of Powell design.

These are a few of Powell proven features. There are others we'd like to tell you about. Write—or consult your nearby Powell distributor.

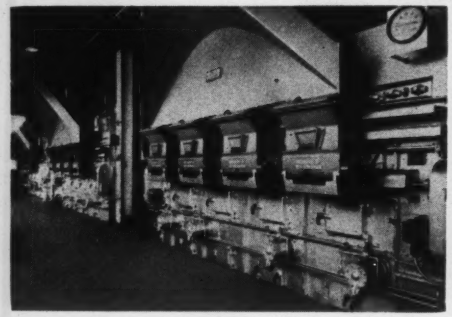
THE WM. POWELL COMPANY
Dependable Valves since 1846
Cincinnati 22, Ohio

BRONZE • IRON • STEEL
CORROSION RESISTANT METALS AND ALLOYS

POWELL...world's largest family of valves



At delivery point, coal moves by belt conveyor to bucket elevator which carries it to roof of plant. Here reversible screw conveyor delivers coal either to 430-ton silo or coal bunkers inside plant. Conveyors and silo by Fairfield Engineering Co. Outside storage is under trestle at right.



Looking down firing aisle at three Babcock & Wilcox 75,000 lb/hr boilers. Coal is gravity fed from bunkers through Stock Equipment automatic scales and nonsegregating distributors to 4-unit Detroit Rotostokers.

Over coal bunkers. Roof screw conveyor moves coal to chute (left). Coal is then dropped to screw conveyor shown and is carried to any of three 100-ton storage bunkers underneath.

Coal sets pattern for low-cost steam

Fabric finisher burns coal for economy and availability

Modernity is the keynote of the new plant of Carlisle Finishing Co., a division of Cone Mills Corporation, Carlisle, S.C. Advanced planning and up-to-date techniques are evident throughout the company's entire operation.

The power plant, too, reflects this thinking . . . *coal* is used to generate the steam required for heating and processing. Chosen for its economy and availability, coal is burned and handled automatically by the latest equipment for peak efficiency. Also, the interior of this plant—designed by the consulting firm of J. E. Sirrine Co., Greenville, S. C.—has been decorated in cheerful colors to match the cleanliness of operation.

Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

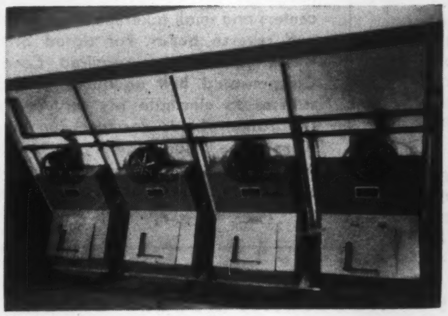
Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

BITUMINOUS COAL INSTITUTE

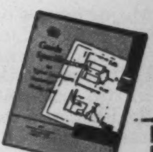
Department ME05, Southern Building, Washington 5, D. C.

See our listing in *Sweet's*



Ash hoppers below furnaces drop ashes into sluice line for disposal. Ash handling system by United Conveyor Co. Fly ash from Western Precipitator collectors is reinjected by high velocity air.

SEND COUPON FOR NEW BCI PUBLICATIONS.
Guide Specifications, with complete equipment criteria and boiler room plans:



BITUMINOUS COAL INSTITUTE
Southern Building, Washington 5, D. C. **ME05**

Gentlemen—please send me:
☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker); ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker); ☐ GS-3 (automatic package boiler for heating and process plants). ☐ Case histories on larger plants.

Name

Title

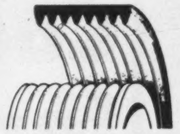
Company

Address

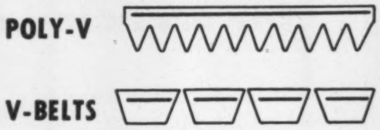
City Zone State

R/M POLY-V® DRIVE

SOLVES SERPENTINE DRIVE PROBLEMS

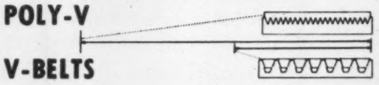


POLY-V ELIMINATES "MATCHING" PROBLEM



The Poly-V Belt is a SINGLE UNIT across full width of sheave—NOT an assembly of SEVERAL V-BELTS.

POLY-V DELIVERS MORE POWER



Poly-V increases the drive capacity 30% to 50% (more in many cases) in the same space as standard V-belt drives.

NO OTHER belt drive delivers more power in the same space than Poly-V!

R/M POLY-V® DRIVE . . . "MORE USE PER DOLLAR"

V-belt slip caused excessive belt wear and frequent belt replacement on the serpentine drive of the Garnet cotton felt machine pictured above. Installation of R/M Poly-V Drive eliminated the slipping problem . . . and increased belt drive service from an average of 3 months to over a year without replacement or loss in tension.

Major causes of drive trouble are engineered *out* of R/M's patented, new Poly-V Drive. Poly-V's unique single unit belt design eliminates "length matching" problems and downtime for belt replacements. Belt speed ratio and position remain constant from no load to full to run smoother *and* cooler—with less wear on belt and sheaves! And because Poly-V belts have *twice* the tractive surface of ordinary multiple V-belts, a Poly-V Drive can deliver up to 50% *more* power in the *same* space as a multiple-belt drive . . . or *equal* power in as little as ⅔ the space!

Just two cross sections of Poly-V belt meet *every* heavy duty power requirement. Let an R/M representative show you how the proper Poly-V* Drive for your application can add up to longer, trouble-free drive service . . . "More Use per Dollar." Write for Bulletin M141.

*Poly-V is a registered Raybestos-Manhattan trademark.

Condor Endless Belts

Condor Whipcord Belts have outlasted as many as 10 ordinary belts on the toughest drives—drives with short centers and small take-ups, small pulleys and reverse bends. For closed drives where fasteners are required, Condor Compensated Belt equalizes belt ply stresses to eliminate ply rupture and separation—holds fasteners up to 4 times longer than ordinary belts. Both are available in a selection of drive surfaces to meet your machine tension requirements.

RM 938

BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES

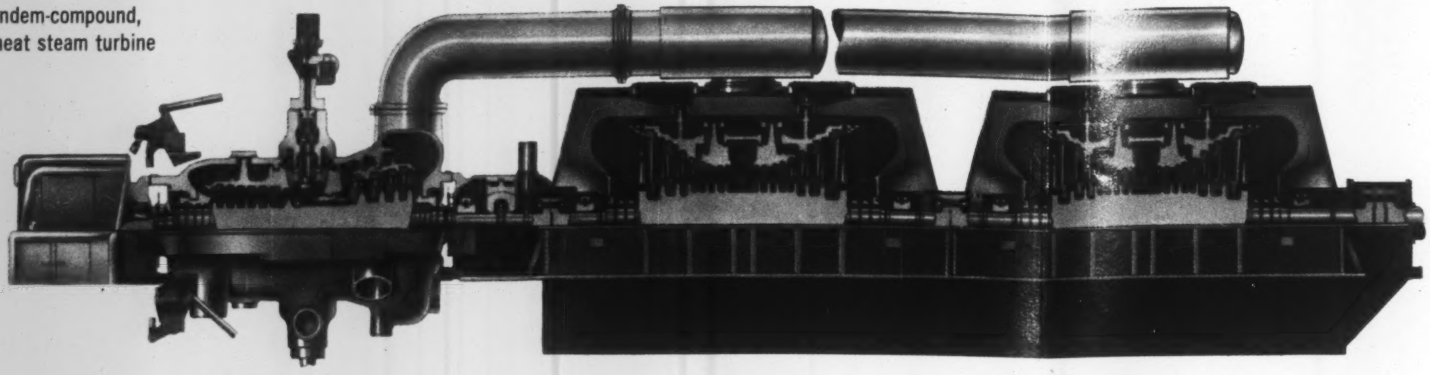
MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

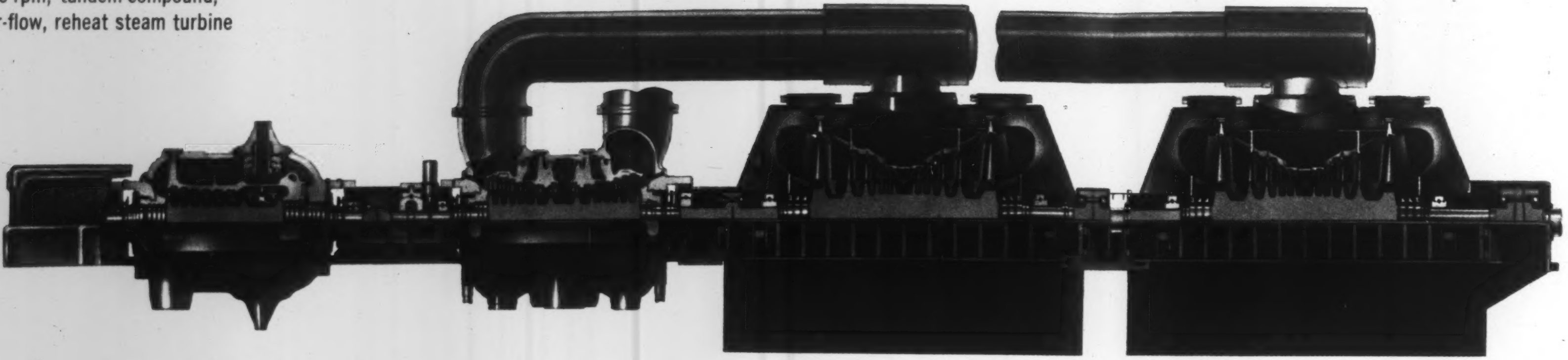
RM

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

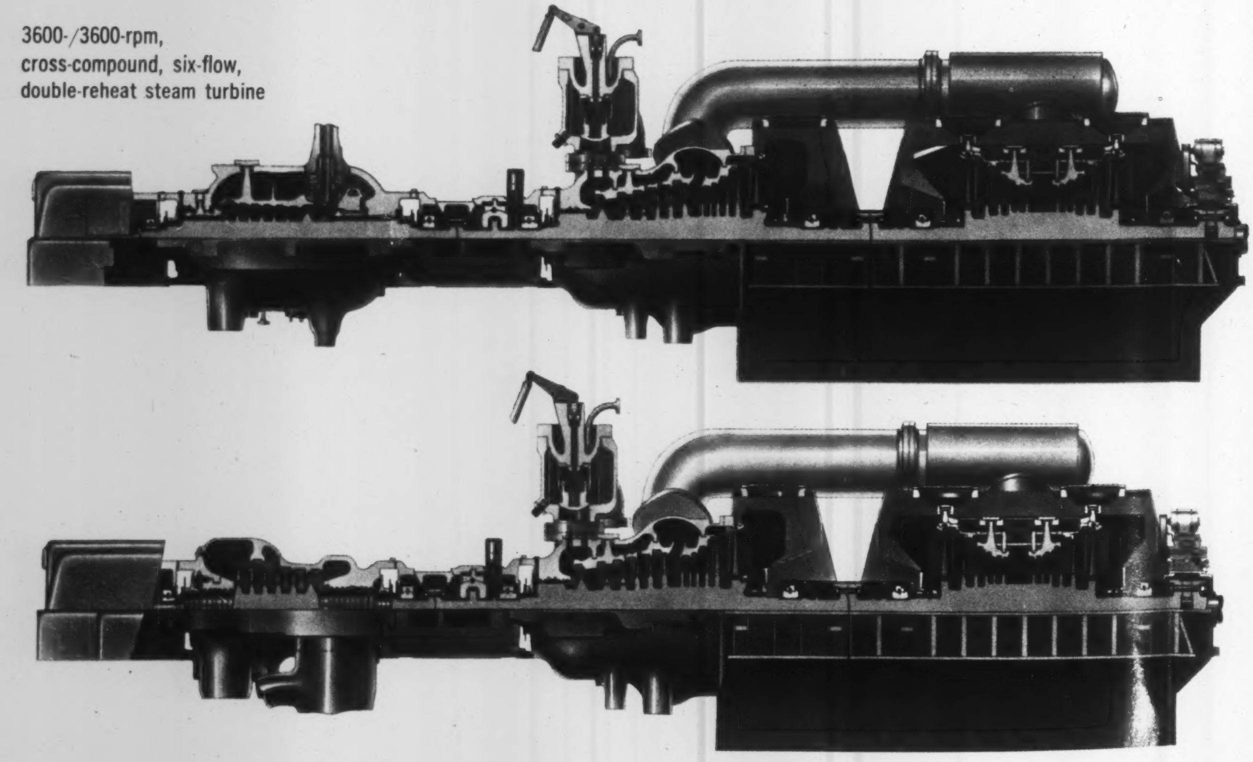
3600-rpm, tandem-compound,
four-flow, reheat steam turbine



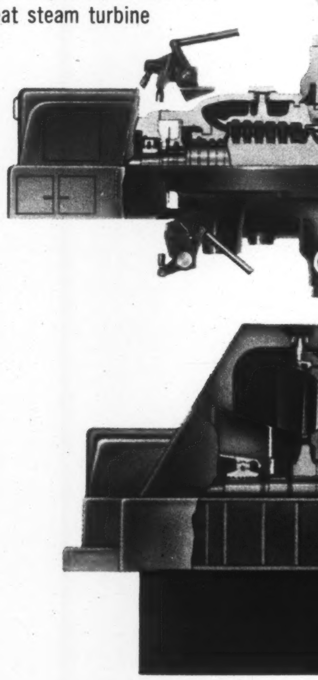
3600-rpm, tandem-compound,
four-flow, reheat steam turbine



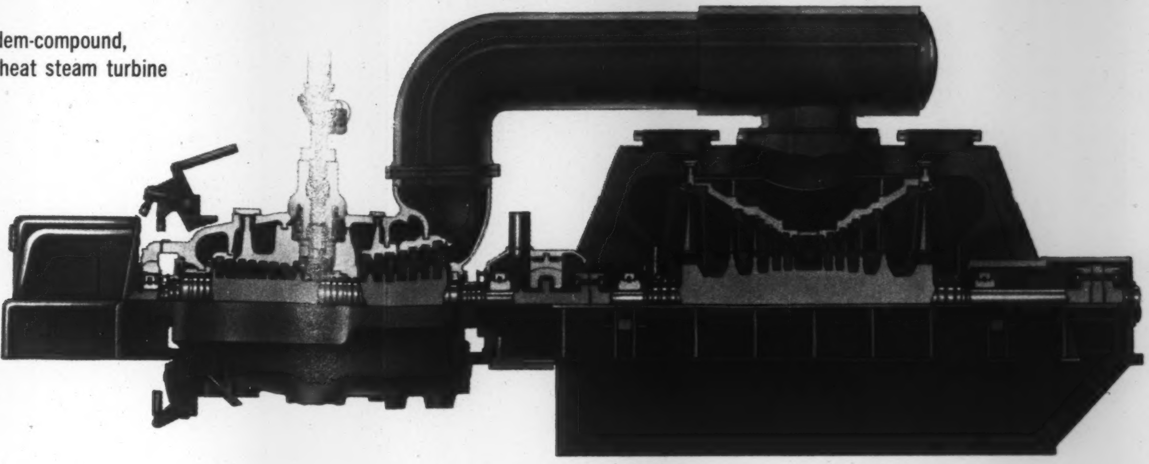
3600-/3600-rpm,
cross-compound, six-flow,
double-reheat steam turbine



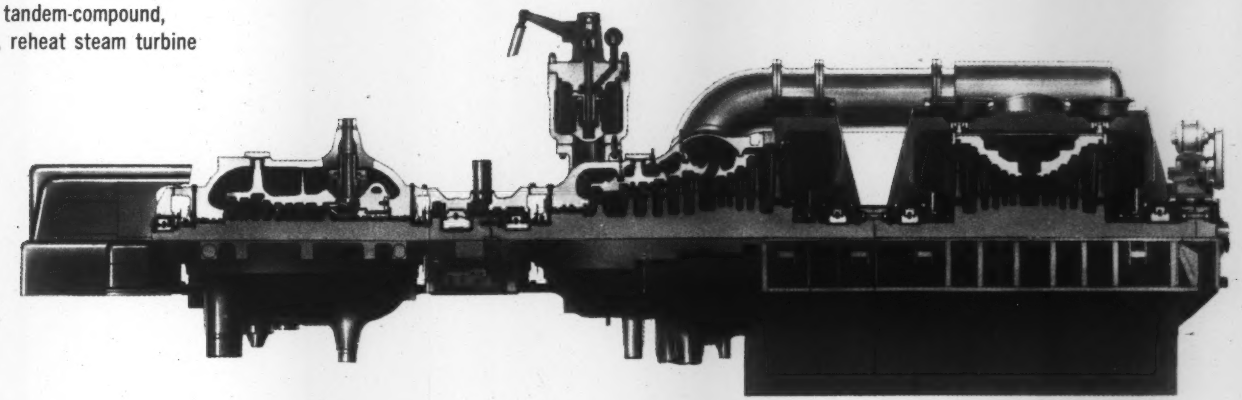
3600-/1800-rpm,
cross-compound, double-flow,
reheat steam turbine

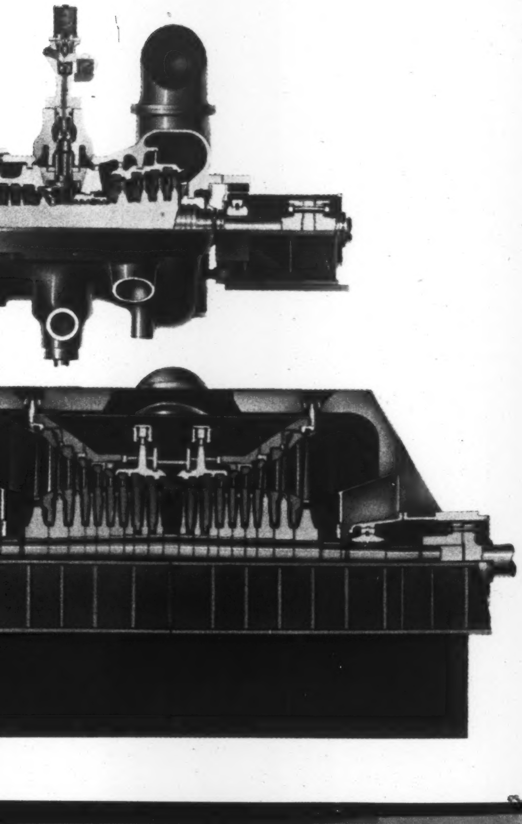


3600-rpm, tandem-compound,
double-flow, reheat steam turbine

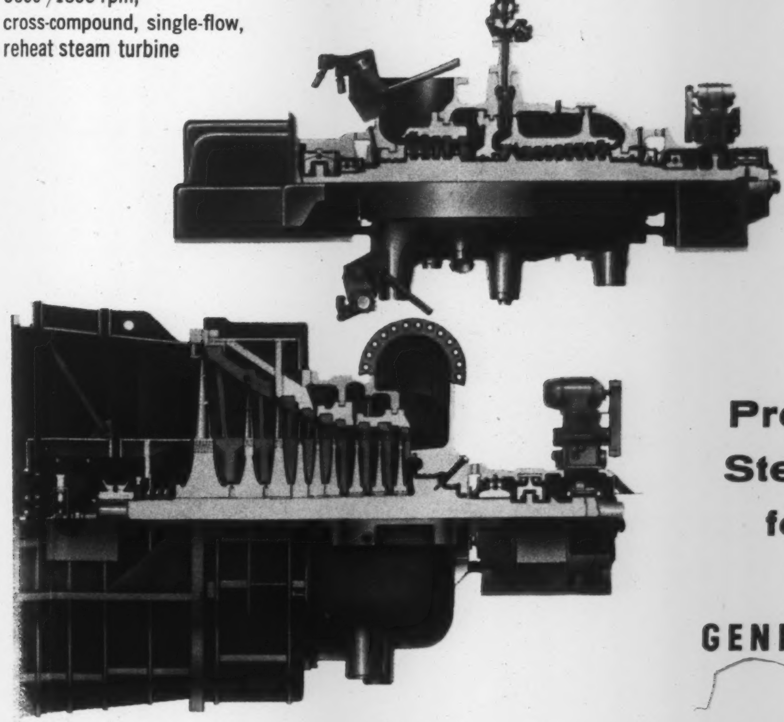


3600-rpm, tandem-compound,
triple-flow, reheat steam turbine





3600-/1800-rpm,
cross-compound, single-flow,
reheat steam turbine



Pre-engineered Steam Turbines for the '60's

100,000 to 600,000 kw

GENERAL ELECTRIC

Why General Electric Offers More For Your Steam Turbine-Generator Dollar Investment

Performance

General Electric's progress in attaining higher operating pressures and temperatures and increased component efficiencies is helping to assure further improvement in the coal rate of electric utilities. With the ever-increasing demand for improved performance, a continuous and diversified program of product development is being carried on in the company's research and development laboratories.

Reliability

General Electric's intensive basic research and development, sound engineering design, modern manufacturing techniques and proper operating practices contribute to the reliability of large steam turbine-generators.

Work performed at the Large Steam Turbine-Generator Department's Materials and Processes Laboratory and the Product Development Laboratory spearheads these efforts.

Service

Completely integrated service—from initial order throughout the unit's operating life—is part of the "added value" purchased with each General Electric steam turbine-generator.

Two-way communication of service information through the turbine-generator Product Service organization enables factory know-how to supplement the efforts of field service representatives, and permits factory specialists to take full advantage of field operating experience.

Improved performance, greater reliability and completely integrated service mean more economical generation of electricity.

GENERAL ELECTRIC

Designed N Turbines for th

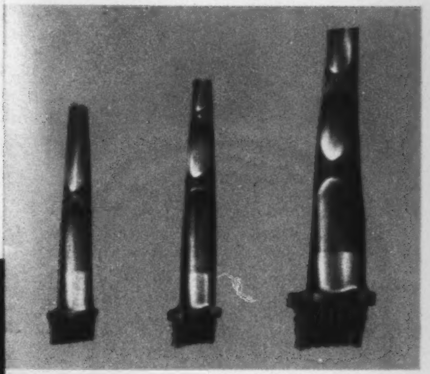
As another step in its continuing progress to help electric utilities keep electric power America's greatest bargain, General Electric is introducing seven advanced-design, pre-engineered steam turbines specifically designed to meet electric generation requirements in the '60's.

The engineering features incorporated in these units—for top reliability, high performance and maximum simplicity—are the result of over 50 years of intensive research and development coupled with bold planning, engineering enterprise and close cooperation with electric utility companies and consulting engineers.

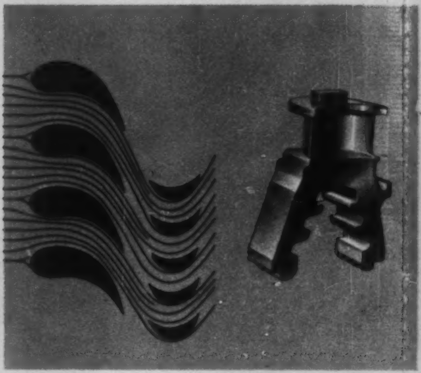
GENERAL ELECTRIC

Now -
the '60's

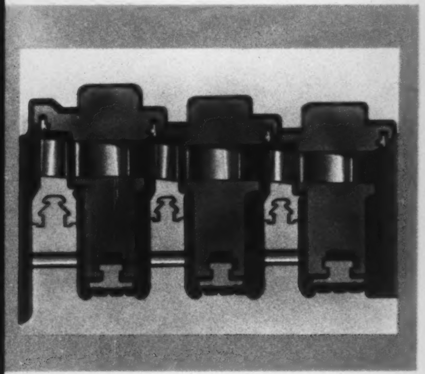
Important Evaluation Features Of General Electric Pre-Engineered Steam Turbines . . .



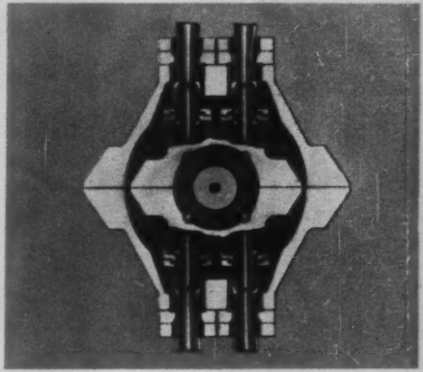
Progressive Bucket Design



Impulse-Type, Solid Rotor Construction



Removable Radial Spill Strips and Spring-Backed Shaft Packing



Nozzle Box Construction

. . . What They Mean To You

- Minimized Investment
- Improved Performance
- Simplified Operation
- Increased Availability
- Greater Reliability
- Accelerated Installation
- Reduced Maintenance
- Extended Life

Progress Is Our Most Important Product

GENERAL ELECTRIC

EFFICIENCY
DURABILITY
QUIETNESS
+ QUALITY
"BUFFALO" TYPE "BL"
for general
air moving

All the things you want for satisfactory air handling at moderate pressures are embodied in the "Buffalo" type "BL" Fan. High efficiency, quiet operation and quality of construction* lead to unparalleled durability on the job. Here are several of the reasons why you will be more than satisfied with this well engineered fan:

- *Inlet* — Minimum turbulence is assured by the smoothly-curved inlet bell. Air flow is further smoothed by directional guide vanes and matching shroud.
- *Wheel* — Streamlined wheel with backward-curved blades achieves peak efficiency. Factory tested and balanced wheel minimizes vibration.
- *Housing* — Smooth air flow is enhanced by the correctly shaped scroll of the wheel-contoured housing.
- *Non-overloading characteristic* — quiet, stable output is provided from free delivery to shutoff.
- *Rugged, durable construction* — Extra-heavy at points of greatest strain and wear — gives long, maintenance-free service.
- *Highest Quality* — backed by the "Buffalo" reputation of 82 years in the air moving field.

For complete details on the "Buffalo" Type "BL" Fan Series, contact your "Buffalo" engineering representative. Or write direct for Bulletin F-104.

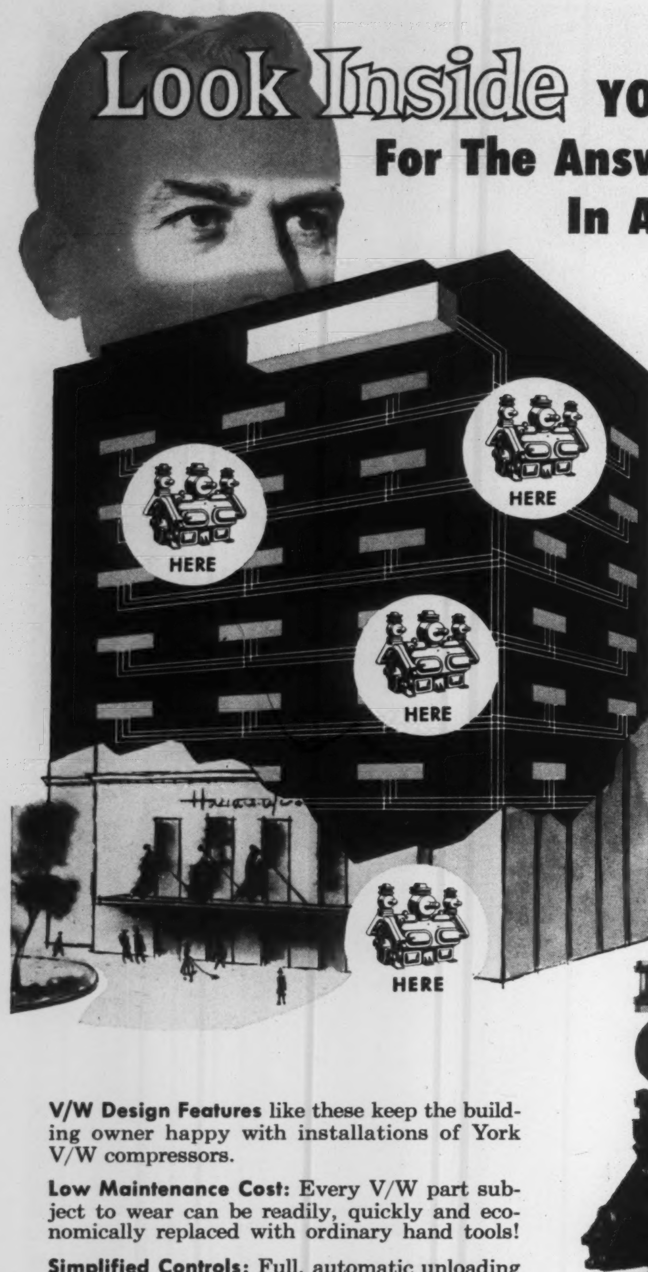
*Every "Buffalo" Fan brings you the famous "Q" Factor—the built-in QUALITY that provides trouble-free satisfaction and long life.

"Buffalo"

BUFFALO FORGE COMPANY
Buffalo, N. Y.
Buffalo Pumps Division, Buffalo, N.Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

Look Inside YORK'S V/W Compressor For The Answer to Installation In Any Available Space



Vibration-Free...Compact...It Eliminates the Need for Heavy Foundations and Shortens Refrigeration Lines

Install It Anywhere: No matter what part of the building is available for the installation of air conditioning machinery—be it basement, roof, or any of the intervening floors—you can use York's compact V/W compressor. York V/W compressors are statically and dynamically balanced to run smooth, quiet and vibration-free. Direct connection may be made to driving motors and costly, heavy foundations and long expensive refrigerant lines can be eliminated. Installation costs are reduced.

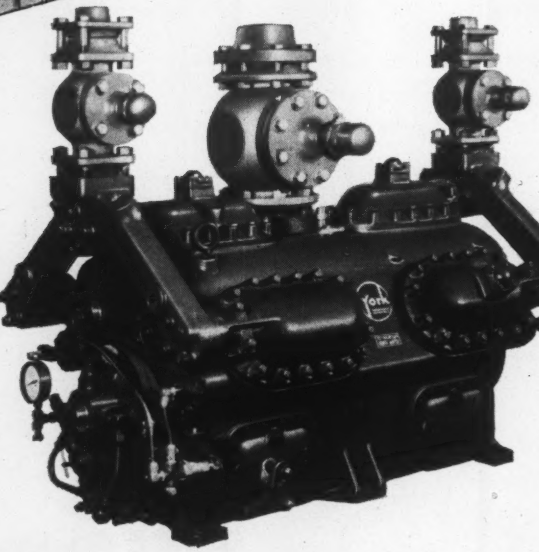
Low Initial Cost: York's seventy-five years of specialization in air conditioning and refrigeration saves you money in initial equipment costs...assures you of performance that means a quality installation everytime.

V/W Design Features like these keep the building owner happy with installations of York V/W compressors.

Low Maintenance Cost: Every V/W part subject to wear can be readily, quickly and economically replaced with ordinary hand tools!

Simplified Controls: Full, automatic unloading permits use of low torque motors, reduces current in-rush.

Low Operating Costs: Built-in capacity reduction features mean power savings in almost direct proportion to product load—28% power at 25% load.



YORK

YORK CORP. SUBSIDIARY OF BORG-WARNER CORP.

YORK B-W

BORG-WARNER
RESEARCH & ENGINEERING
MAKE IT BETTER

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Installations

Hey, Herman...Snap-Tite valved couplings come in big sizes too!

There's a size and type to handle almost anything that flows

Snap-Tite can provide the right size valved coupling for most any use . . . with quick off-on action wherever coupling or shut-off is required.

"H" series valved couplings for high pressure applications. High resistance to heavy line surge. Sizes from 1/8" through 6". Larger sizes on special order.

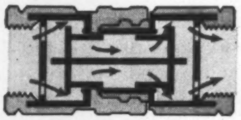
"IH" series valved couplings for greater impact in air lines. 1/8" through 1/2".

"E" series valved couplings for vacuum and very low pressure. Recommended for gravity flow. Sizes from 1/8" to 6". Larger sizes on special order.

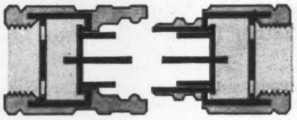
"T" series valved couplings for hard to handle fluids. The only valved quick-disconnect couplings now on the market for fluid temperatures from −40°F to +400°F. Sizes from 1/2" through 3".

Snap-Tite valved couplings are available with two-way or one-way automatic line shut-off. They are normally furnished in alloy steel. Also available in brass, aluminum, or stainless steel with a variety of finishes.

TO USE SNAP-TITE VALVED COUPLING:



CONNECT—Full flow instantly



DISCONNECT—No flow instantly

Write for Snap-Tite Catalog No. 58 for more information on Snap-Tite valved couplings.

★Snap-Tite

UNION CITY 4, PA.

ST-59-02

When you're up to your neck in equipment details . . . call in American-Standard!

You'll save valuable time. The man you talk to speaks your language.

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Let CB&I Experience

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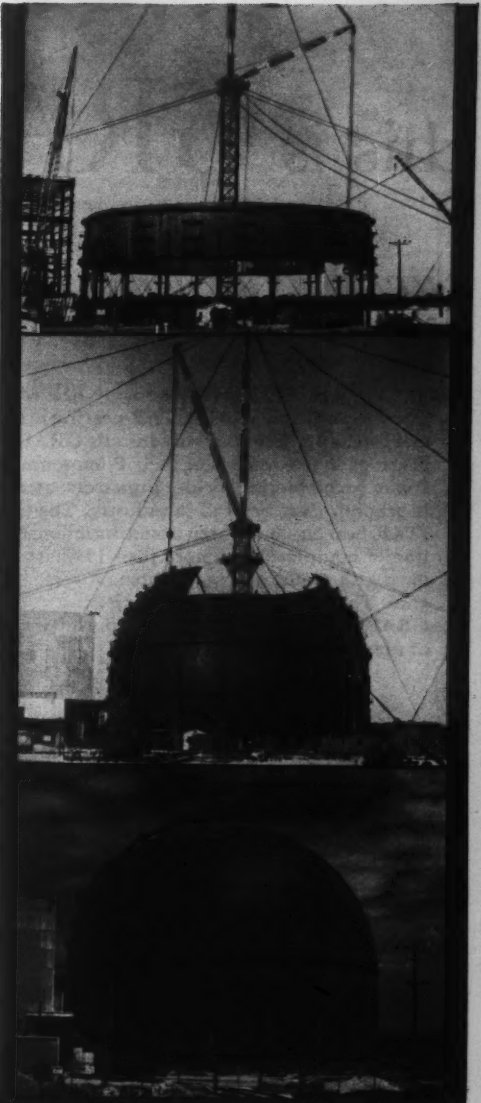
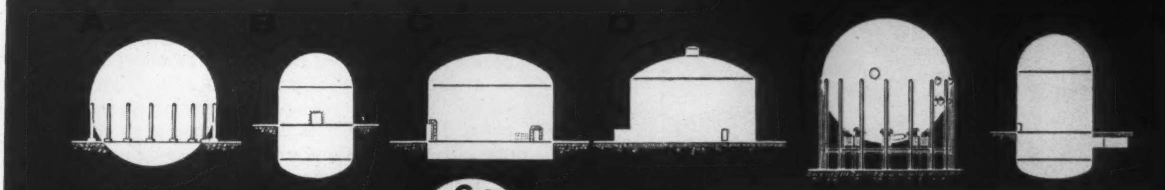
It takes more than a pioneering spirit to build atomic vessels. CB&I's pioneer vessel, an atom smasher for the University of Minnesota, was 16 years old when we completed the "Big Sphere" — 225 feet in diameter — for Knoll's Atomic Laboratory. Since then, 9 additional steel reactor housings have been completed, or are under construction, by CB&I.

These years of research, together with engineering, fabrication and erection for the atomic industry, have brought new experiences . . . even to a company with seven decades of craftsmanship in steel.

CB&I's experience can be of great value to firms which rely on precision-engineering structures. It will pay you to learn *more* about CB&I's *coordinated* services. Write our nearest office for the brochure: *Craftsmanship in Steel.*

THE DRESDEN SPHERE a new sound-color film traces fabrication and erection of a 190-foot sphere. Showings will be arranged upon written request.





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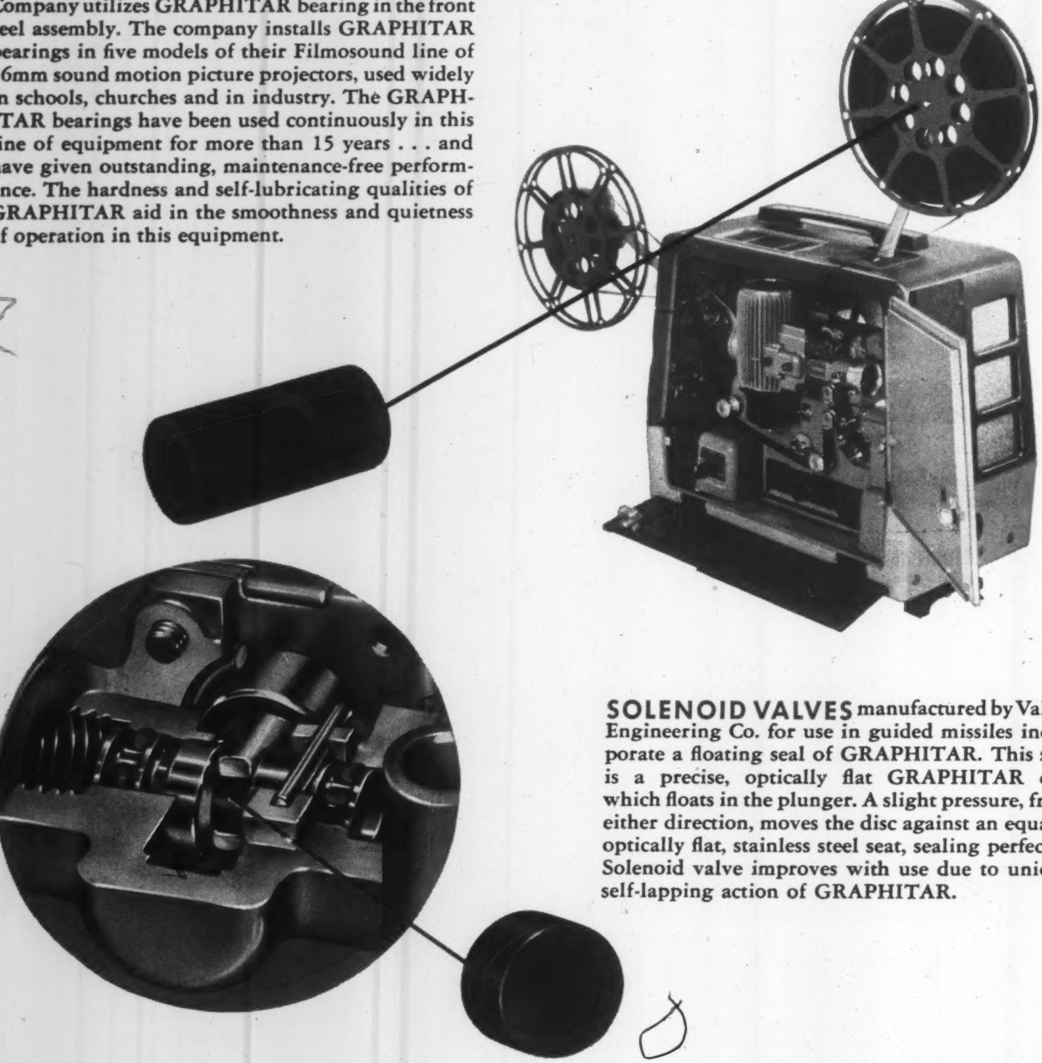
N-1

this is GRAPHITAR®

(CARBON-GRAPHITE)

successful in a wide variety of applications

MOVIE PROJECTOR built by Bell & Howell Company utilizes GRAPHITAR bearing in the front reel assembly. The company installs GRAPHITAR bearings in five models of their Filmosound line of 16mm sound motion picture projectors, used widely in schools, churches and in industry. The GRAPHITAR bearings have been used continuously in this line of equipment for more than 15 years . . . and have given outstanding, maintenance-free performance. The hardness and self-lubricating qualities of GRAPHITAR aid in the smoothness and quietness of operation in this equipment.



SOLENOID VALVES manufactured by Valcor Engineering Co. for use in guided missiles incorporate a floating seal of GRAPHITAR. This seal is a precise, optically flat GRAPHITAR disc which floats in the plunger. A slight pressure, from either direction, moves the disc against an equally optically flat, stainless steel seat, sealing perfectly. Solenoid valve improves with use due to unique self-lapping action of GRAPHITAR.

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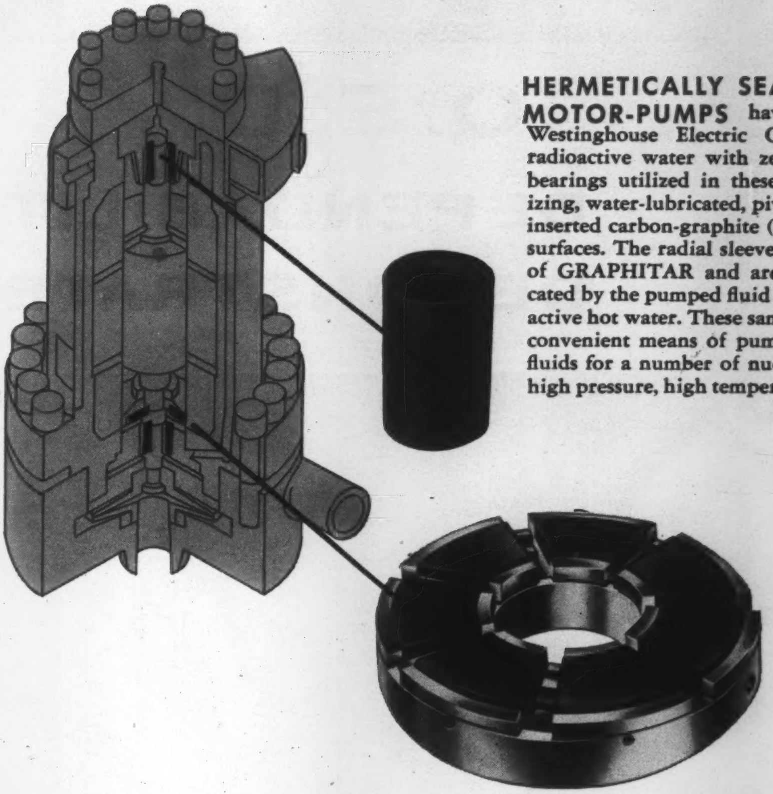
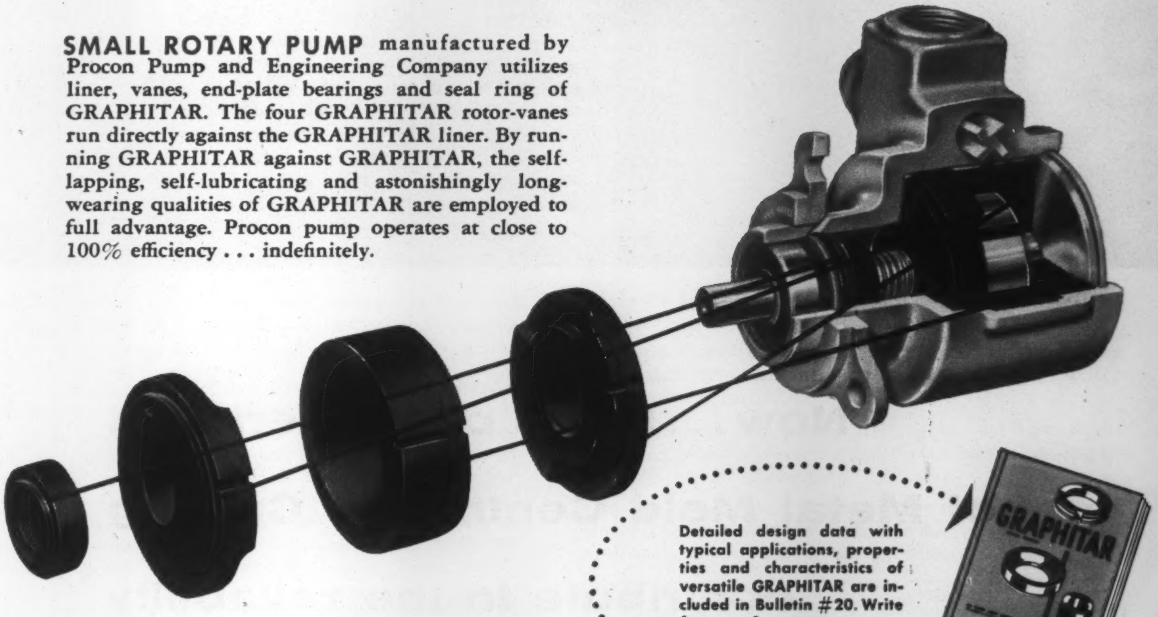
GRAPHITAR® CARBON-GRAPHITE • **GRAMIX®** POWDER METALLURGY • **MEXICAN®** GRAPHITE PRODUCTS • **USG®** BRUSHES



HERMETICALLY SEALED MOTOR-PUMPS have been developed by Westinghouse Electric Corporation to handle radioactive water with zero leakage. The thrust bearings utilized in these pumps are self-equalizing, water-lubricated, pivoted-pad bearings with inserted carbon-graphite (GRAPHITAR) bearing surfaces. The radial sleeve bearings are also made of GRAPHITAR and are designed to be lubricated by the pumped fluid only, in this case, radioactive hot water. These same pumps have proven a convenient means of pumping high temperature fluids for a number of nuclear reactors and other high pressure, high temperature fluid applications.

SMALL ROTARY PUMP manufactured by Procon Pump and Engineering Company utilizes liner, vanes, end-plate bearings and seal ring of GRAPHITAR. The four GRAPHITAR rotor-vanes run directly against the GRAPHITAR liner. By running GRAPHITAR against GRAPHITAR, the self-lapping, self-lubricating and astonishingly long-wearing qualities of GRAPHITAR are employed to full advantage. Procon pump operates at close to 100% efficiency . . . indefinitely.



Detailed design data with typical applications, properties and characteristics of versatile GRAPHITAR are included in Bulletin #20. Write for your free copy.

R-265-2

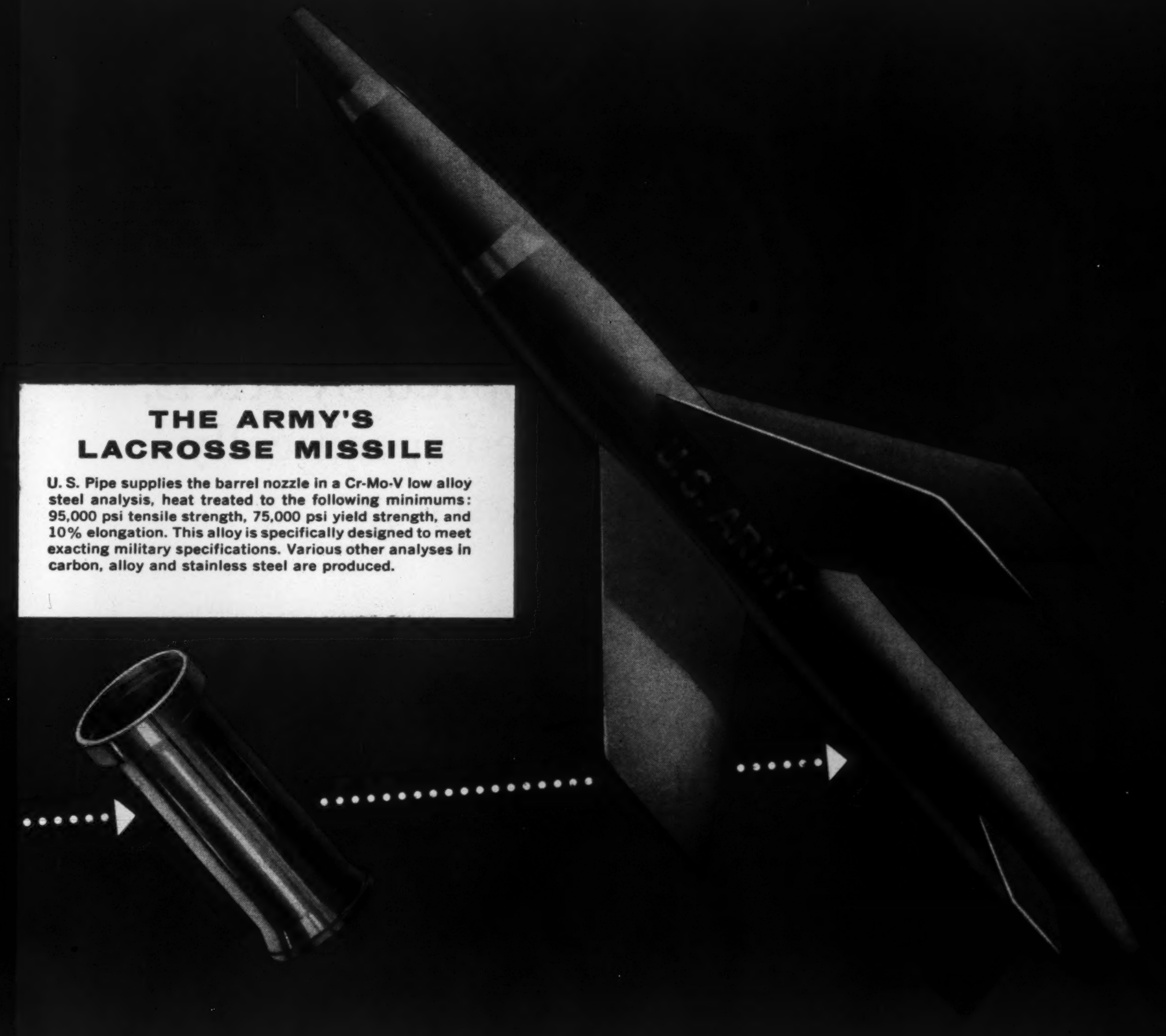
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

Q. E. D.

DEPENDABILITY DEMONSTRATED

Now . . . basic characteristics of Metal Mold Centrifugal Casting contribute to the reliability of new Lacrosse Missile



THE ARMY'S LACROSSE MISSILE

U. S. Pipe supplies the barrel nozzle in a Cr-Mo-V low alloy steel analysis, heat treated to the following minimums: 95,000 psi tensile strength, 75,000 psi yield strength, and 10% elongation. This alloy is specifically designed to meet exacting military specifications. Various other analyses in carbon, alloy and stainless steel are produced.

Centrifugal casting, a direct production approach to quality, is now finding new and increasingly useful applications in rocketry and missile engineering.

U.S. Pipe, for example, supplies the alloy steel barrel nozzles for the Army's Lacrosse Missile as semi-finished, partially hot-forged lengths. These production pieces are being supplied to The Martin Company, Orlando, Florida — prime contractor for the Lacrosse, and to Parish Pressed Steel, Reading, Pennsylvania — subcontractor to The Martin Company. The contractors then finish machine them for assembly in the propulsion units.

Centrifugal casting offers ordnance design engineers several outstanding advantages:

1. Versatility. Many different alloy and stainless steel analyses, sizes and contours can be produced starting with a hollow billet.

2. Dependability. Years of experience in producing metal mold centrifugal castings assures high quality and reproducibility.

3. Economy. Maximum utilization of the *right* material produced with a minimum of processing to achieve overall efficiency.

Can these basic qualities meet the requirements and lower the cost of your material needs? Write today and outline your particular problem.

Size Range & Composition Flexibility
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Types of Steel Cast, Carbon, Alloy and Stainless—all standard AISI and ACI grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

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The Case For 105mm Miniaturization of Engineering Drawings

Micro-Master® 105mm, supplied by K&E, is the only system designed specifically for engineering drawings

Micro-Master 105mm offers the general advantages you expect of any miniaturization system – space savings, protection of costly originals, and ready distribution of duplicates. But Micro-Master provides these advantages *without* over-mechanization. A 105mm negative – measuring a generous 4 by 6 inches – is large enough to be located easily and read quickly without elaborate scanning and sorting devices. In addition, a national network of K&E dealers stands ready to provide the 105mm service you need.

A Complete System from Film to Print

Micro-Master is a totally integrated system for photographing, film processing and final reproduction or projection printing. Completely precision-engineered – from optics through films, papers and chemicals – the system provides extremely sharp, high-contrast "thin" negatives that furnish high-quality, absolutely uniform prints. Critical alignment of camera and projector, and special vacuum frames which hold materials absolutely flat, are typical of the optical and mechanical features that make the Micro-Master system an engineering aid of highest quality.

No Distortion in Blow-Backs

Maximum reduction or enlargement for Micro-Master 105mm is 10 diameters —not up to 30 diameters as with smaller negatives. Thus, when drawings as large as 40 by 60 inches are reduced or re-enlarged, they retain a clear, sharp quality – even in the corners. There is no distortion or loss of detail, for all Micro-Master reproductions are made inside the photographic "quality barrier" of 10 diameters. Projection prints can be made on inexpensive paper as well as on cloth or film.

Like-New Prints from Worn Originals

Old originals can be restored, too – even when badly damaged. The Micro-Master process uses *reflected* rather than transmitted light. Thus, detail which has been lost through light absorption – due to dirt or discoloration – will "snap back" on the film – giving you clean prints with clear backgrounds and sharp black lines equal to ink lines. The large negative size makes it easy to see and eliminate unwanted areas by "opaquing out." Any small paint brush can be used for this purpose.

Easy to Read . . . Always Accessible

You can read almost every detail on a 105mm negative just by holding it up to a window or other light source. Table viewers are recommended for close study, but are *not necessary* in the "search and selection" phase. In a large plant or office, engineers can find and consult from 105mm negatives without waiting for search and delivery of originals, and without having to blow back tiny reductions to a readable size. Engineers or technicians at branch plants, warehouses or field installations can maintain compact, complete files of project information – accessible at any time without special equipment.

Easy to File, Easy to Mail

Micro-Master is a miniaturization system providing *individual* negatives that meet archival requirements. Each negative is kept in its own 5″ by 8″ envelope. There is ample space on the envelope for large, legible identification coding and other information. Over 12,000 drawings can be stored in a standard 5″ by 8″ card file cabinet. No complicated cross-indexing is needed, for negatives of original drawings and all subsequent revisions can be grouped in the same file, ready for immediate reference. The absence of sorting devices eliminates scratches and other film damage resulting from excessive mechanical handling.

See Your K&E Dealer for Information, Equipment, Service

A camera, projector, three types of viewers, and all necessary printing accessories are available with the Micro-Master system, and all equipment can be obtained through your local K&E distributor. He can also furnish 105mm reductions and enlargements of your drawings as a service. For complete information, call your K&E dealer, or write to Keuffel & Esser Co., Dept. ME-5, 300 Adams St., Hoboken, N. J.

1634

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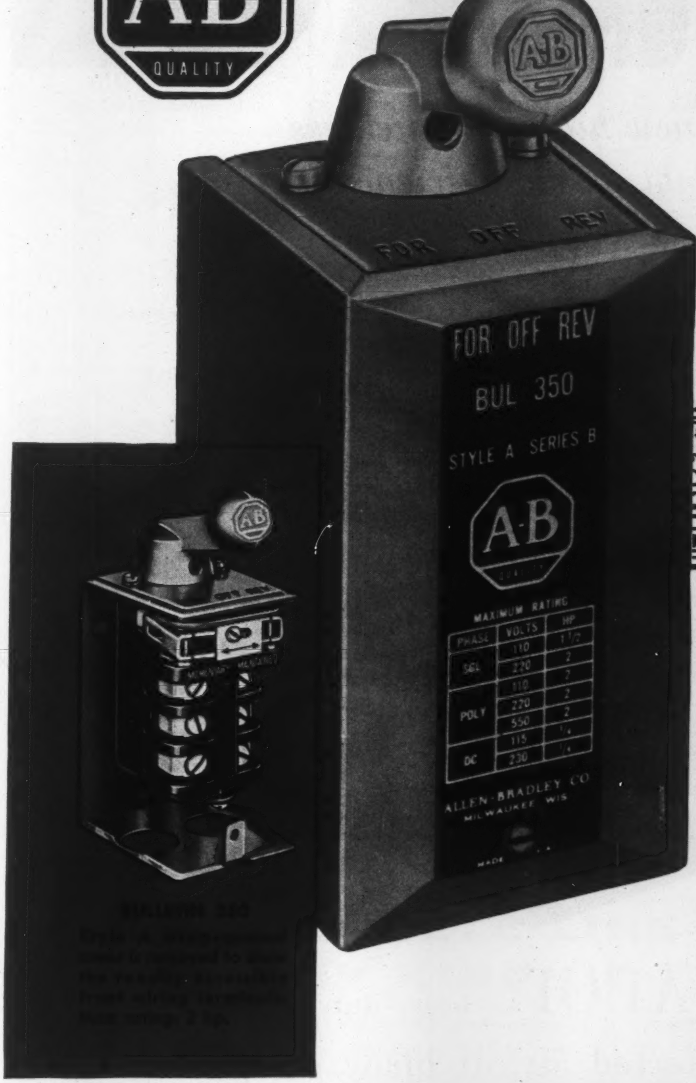
ALLEN-BRADLEY REVERSING DRUM SWITCHES


FOR OFF REV
FOR OFF REV
BUL 350
STYLE A SERIES B
A-B
MAXIMUM RATING
PHASE VOLTS HP
SGL 110 1½
220 2
POLY 110 2
220 2
550 2
DC 115 ¼
230 ¼
ALLEN-BRADLEY CO
MILWAUKEE WIS

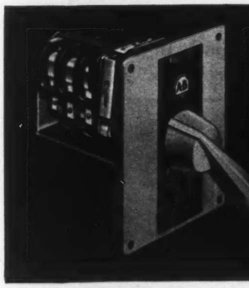
BULLETIN 350

Style A wrap-around cover is removed to show the [illegible] mechanism [illegible] front wiring terminals. Max. rating: 2 hp.

... styled to match the most modern production machines!

Inside and out—this Allen-Bradley drum switch is *all* new. Its trim, modern lines and attractive die-cast aluminum handle will give your production machines "up-to-the-minute" styling.

But there is more than beauty to this new switch. The rugged switch mechanism is a self-contained unit—independent of the enclosure. Misalignment and binding *cannot* occur. The base mounts directly on machine surfaces—without using spacers. And with the wrap-around cover removed, terminal screws are exposed for fast wiring—from the front. Changeover from momentary to maintained contact operation can be made in seconds. Investigate this new "leader" in its field. Send for Publication 6091.



[illegible] CAVITY MOUNTING

A-B Style [illegible] reversing switches can be furnished with sealed shaft and [illegible] gasketed [illegible] for cavity mounting [illegible]

PANEL MOUNTING

The new Style [illegible] [illegible]

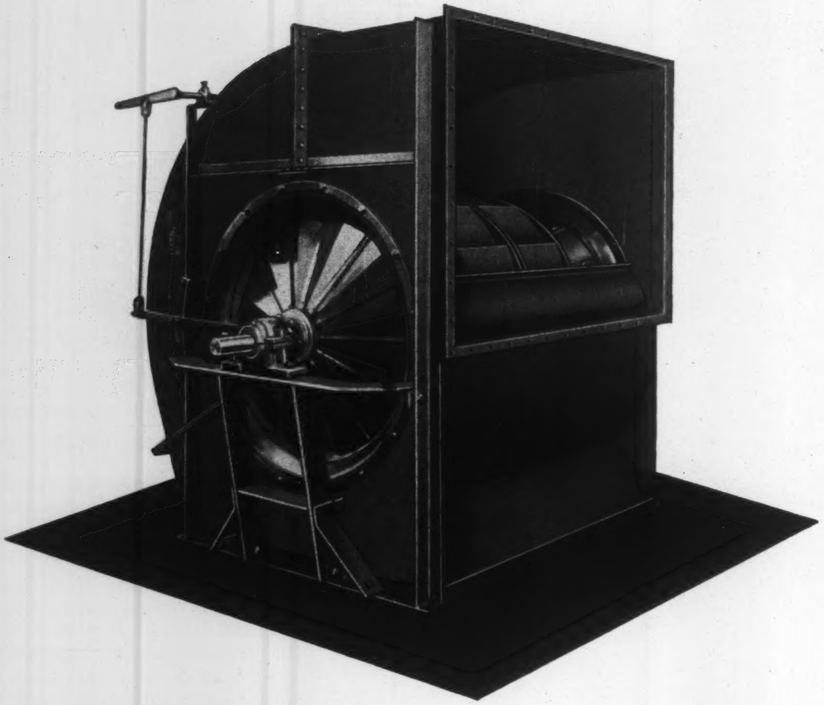
ALLEN-BRADLEY

Quality Motor Control

Allen-Bradley Co., 1308 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

CLARAGE

Presenting new highs in quietness and dependable broad efficiency...



NEW DYNAFOIL heavy-duty FAN

featuring a perfected airfoil blade design

With this new Clarage Type AF Dynafoil Fan you get stable high efficiency where it counts—under actual operating conditions.

Ideally suited to mechanical draft and heavy-duty applications, such as industrial processes, conduit type air conditioning, and tunnel ventilation, this latest in the Clarage line of superior fan equipment is built in 13 sizes, Classes II, III, and IV construction.

WRITE FOR CATALOG 859 which provides outlined dimensions and description of new Clarage Type AF Dynafoil Fans. Or contact nearest office.

CLARAGE
Dynafoil Fans

Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

Free-Flexing Expansion Joints
Hinged Expansion Joints
Dual Expansion Joints
Expansion Compensators
Flexible Connectors
Controlled-Flexing Expansion Joints
Balanced Expansion Joints

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Flexonics has the equipment – as well as the experience and the skill – to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from Flexonics warehouses. They all add up to expansion joints that you can *install and forget* – plus expansion compensators, flexible connectors, and the all-new Flexonics pipe alignment guides—to take care of any kind of pipe motion!

Today—write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

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EJ-235

TOMORROW'S
ENGINEERING
TODAY

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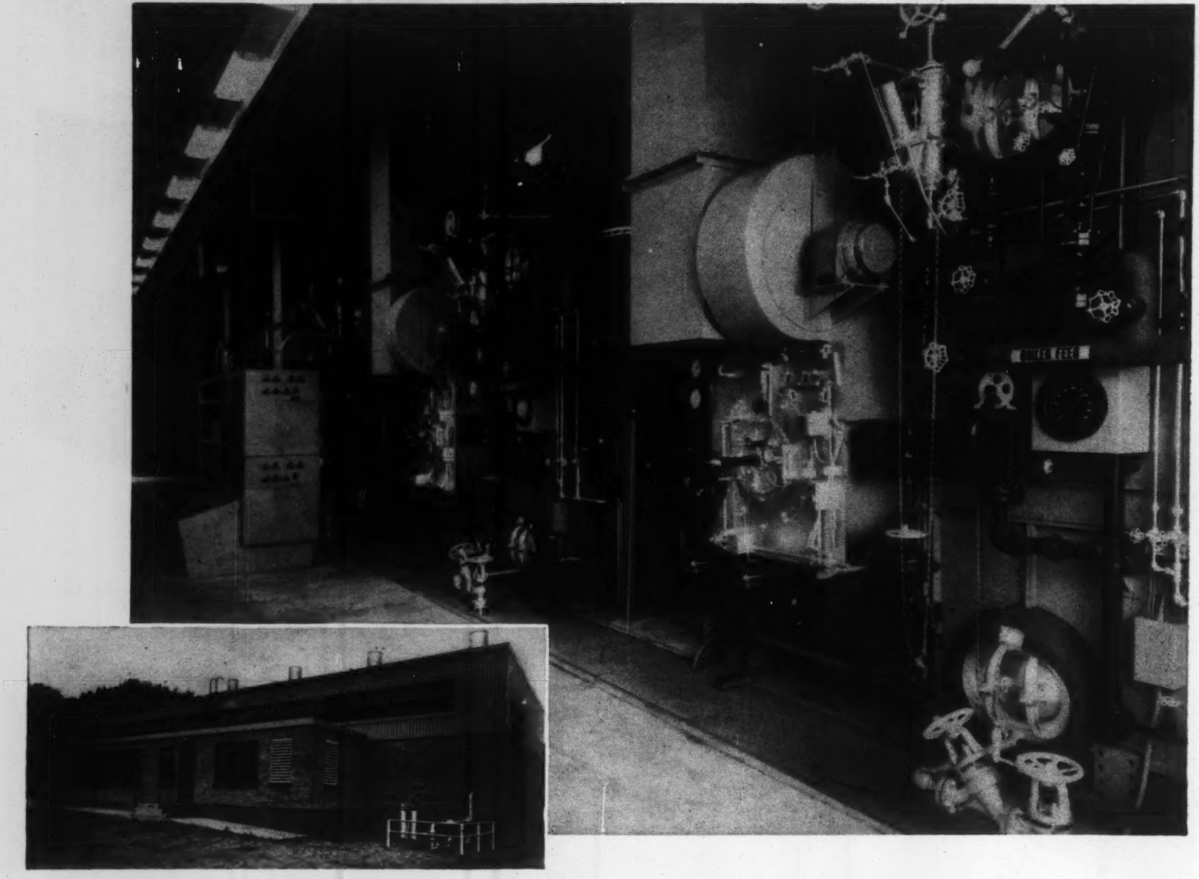
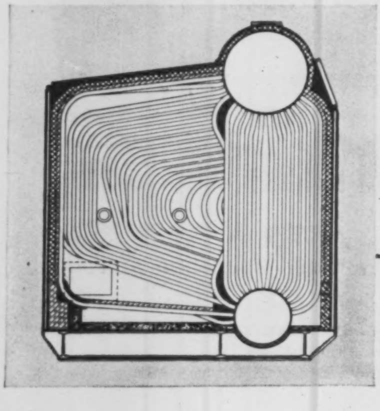
KEELER **dk** package steam generators

THE HASKELL INSTITUTE—Lawrence, Kansas
U. S. Government Indian School operated by
United States Department of the Interior, Bureau of Indian Affairs
Washington, D. C.
Arthur O. Allen, Engineering Advisor



THE JIM THORPE POWER PLANT

at Haskell Institute
— Architects & Engineers —
WILSON & CO., SALINA, KANSAS
— General Contractor —
C. L. MAHONEY CO., INC., KANSAS CITY, KANSAS
— Supervision of —
Construction & Equipment Installation
BUREAU OF INDIAN AFFAIRS, BRANCH OF PLANT DESIGN & CONSTRUCTION, ALBUQUERQUE, N. M.
Edward A. Poynton, Chief



With an eye for economy and efficiency, the new central heating plant at the Haskell Institute is equipped with four multi-purpose Keeler Type D K package steam generators. They supply the entire steam needs of the several buildings at this U. S. Government Indian School located on a 280-acre tract near Kansas City.

Three of the units are 25,000-lb stm/hr capacity boilers equipped for combination oil and gas firing, and the fourth is an 18,000-lb stm/hr gas-fired unit.

A *"better efficiency than required"* report confirms the wisdom of the selection, together with further statements which indicate *a 20% drop in fuel costs,* when firing the new Keeler Type D K units at the same capacity as the previous equipment.

There's a size and type Keeler steam generator available for your requirements—up to 200,000-lbs stm/hr—with the full economy, efficiency, versatility and dependability that has earned Keeler its reputation as "builders of better boilers since 1864"! *Write or phone for free bulletins, full data and specifications . . .*

—ESTABLISHED 1864—

The Seal of Quality in Water Tube Steam Generators

E. KEELER COMPANY
400-500 West St. • Williamsport, Penna.
—OFFICES IN PRINCIPAL CITIES—
In Canada: Canadian Vickers, Ltd., Montreal, P.Q.

KEELER WATER TUBE *Boilers*

CLEVELAND
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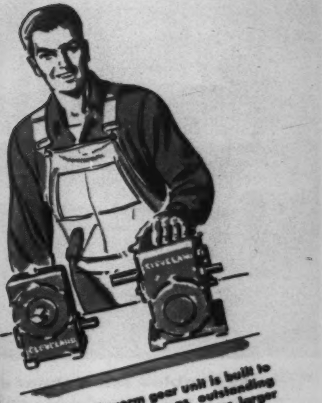


Every small worm gear unit is built to precision standards—as outstanding in quality and performance as larger size Clevelands.

Illustrated above are the 10 AT (left) and 00 D (right) speed reducers.

Enjoy the benefits of worm gear drives in smaller CLEVELAND speed reducers

WHEN you want a quiet, powerful, dependable drive for a small machine, choose a Cleveland Worm Gear Speed Reducer.

As built by Cleveland, the worm gear reducer is a drive of many advantages:

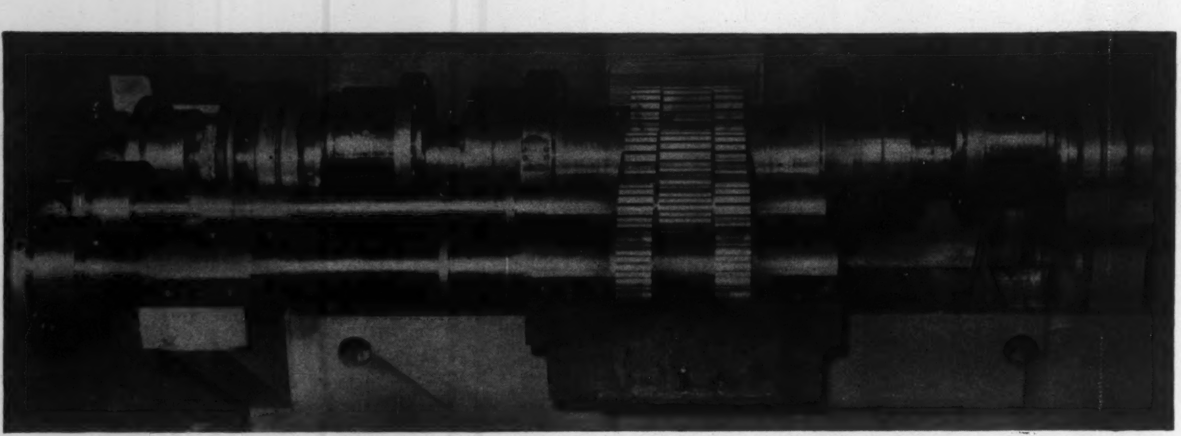
1. It is compact and inherently quiet, transmitting power with smooth, uninterrupted torque flow.
2. Its right-angled design saves valuable space.
3. It has a minimum of moving parts.
4. Shock load resistance and other factors of safety are high.
5. Rate of wear of case hardened steel worm on nickel-bronze gear is very low, insuring long life.

Write for Bulletin 114F which illustrates and gives engineering data on smaller size Clevelands—many now available for immediate delivery.

The Cleveland Worm & Gear Company,
3264 East 80th St., Cleveland 4, Ohio.

Subsidiary of
Eaton Manufacturing Company
Affiliate: The Farval Corporation

CLEVELAND
Worm Gear
Speed Reducers



Assembled main shear shaft and front gate drive shaft used in model 541 guillotine flying shear. Shafts range up to 9¼" in diameter and 16' in length. All shafts are fabricated of type 4340 nickel alloy steel.

Giant "flying" shears need...

Nickel alloy steel for fatigue strength and shock resistance in heavy shafting

Cutting metal strip is a shaft breaking job!

It takes enormous blade pressures applied as much as 180 times a minute 250,000 times a day. That's rough on the shafting that activates the shears.

How does The Hallden Machine Company design shafting to take this kind of punishment?

They do it with 4340 nickel-chrome-moly steel.

Some shafts are as large as 9¼ inches in diameter. But even in these heavy sections, 4340's good response to heat treatment provides the toughness and fatigue resistance needed.

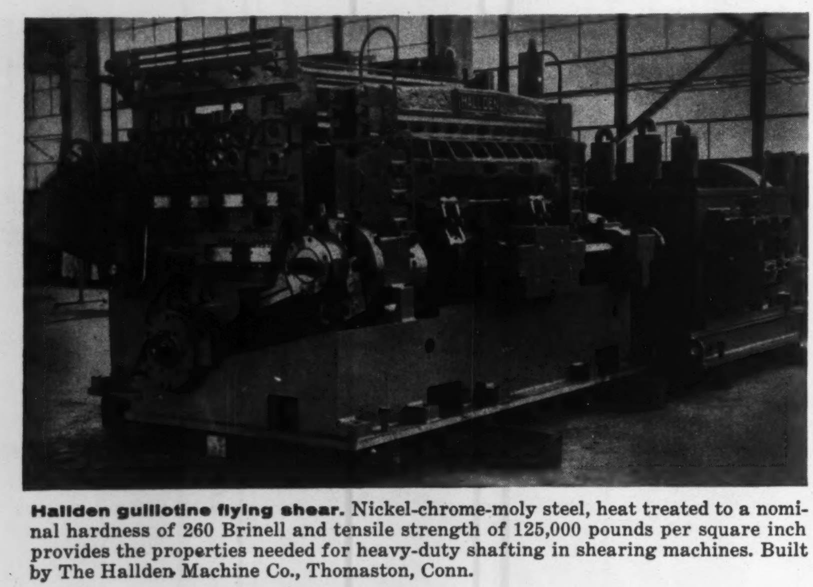
For these reasons, type 4340 is now standard for bull... main shear and drive box shafting and all other heavy-duty shafting. The extra stamina it delivers pays off for Hallden customers in long, dependable service.

Do you have a difficult or new design problem that demands a material with special properties? If so, you might find exactly what you need in one of the standard grades of nickel alloy steel.

The booklet "The Properties of Heat Treated Wrought Nickel Alloy Steels" helps you choose the right steel for the job. It gives you useful information on the many different nickel alloy steels and describes their range of properties. Heat treatment methods... for both carburizing and direct hardening steels... is explained in detail. Ask for a copy of this helpful bulletin. We'll be glad to send it to you.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall St. New York 5, N. Y.

INCO
TRADE MARK



Hallden guillotine flying shear. Nickel-chrome-moly steel, heat treated to a nominal hardness of 260 Brinell and tensile strength of 125,000 pounds per square inch provides the properties needed for heavy-duty shafting in shearing machines. Built by The Hallden Machine Co., Thomaston, Conn.

INCO NICKEL

NICKEL ALLOYS PERFORM BETTER, LONGER

MECHANICAL ENGINEERING

VOLUME 81 • NUMBER 5 • MAY, 1959

For 300,000 Engineers

Editor, J. J. JAKLITSCH, JR.
Editor Emeritus, GEORGE A. STETSON

Unity of the engineering profession continues to be a major topic of discussion among engineers. And many possible ways of achieving a unity organization currently are being explored. Engineers Joint Council figures prominently in all of them. It is urged, therefore, that all ASME members read the 1958 Annual Report of Engineers Joint Council so that they will be better informed about the aims, purposes, and accomplishments of EJC and what it should mean to them as members of the engineering profession. The report is available for the asking from EJC, 29 West 39th Street, New York 18, N. Y.

Growth of EJC is an important item, the report states. Twenty societies with an enrollment of nearly 300,000 individual members are now in its membership.

Another important step that was taken during the year, the report notes, was the completion of the incorporation of EJC under the laws of New York State as a nonprofit organization. Thus EJC has been transformed from an informal and voluntary grouping of societies into a definite legal entity with formal charter, constitution, and by-laws. This new status gives EJC greater stability and clearly defined purpose.

According to the report, the work of both the Engineering Manpower Commission of EJC and the National Water Policy Panel progressed. Discussions are under way with the National Science Foundation leading toward a major revision and expansion of the National Engineers Register from the current 8 per cent sample of our qualified engineering population to an 80 per cent representation. And, at the suggestion of ASME, EJC is taking steps to develop a National Transportation Policy.

The report also points out that the Committee on International Relations did a remarkable and praiseworthy job of representing American engineers and engineering in a favorable manner to our fellow engineers in the two Americas, Europe, and the rest of the Free World. This was accomplished largely through the meetings of UPADI, the Pan American organization of engineers of all principal nations of both Americas; the Canadian Sectional Meeting of the World Power Conference; the Sixth Congress on Large Dams; and the Sixth Conference of the Engineering Societies of Western Europe and the United States (EUSEC).

Getting back to EJC and unity, it is interesting to note in the report that the Public Relations Committee has received a suggestion that EJC issue a periodical publication. This sounds like a good idea and would be a great step toward unity through personal contact with engineers at the grass-roots level. A publication is tangible and permanent evidence of the existence of any organization. Imagine circulating a newsletter, or better yet, a full-fledged professional journal to every one of the 300,000 engineers in the 20 EJC societies.

To tell the EJC story, the magazine could present positive ideas such as: (1) The basic philosophy, ideals, and ethics that are common to all EJC societies; (2) the problems confronting the community, the nation, and the free world which the engineer is competent to solve and explain to his fellow citizens; (3) the advantages to employers of having their young engineers participate not only in the technical phases of engineering-society activities but in those broader responsibilities of professional men as well.

While many problems, such as financing, would be faced by EJC in launching a periodical, it could well be the means of welding 300,000 engineers into a publicly recognized profession.—*J. J. Jaklitsch, Jr.*

A CHALLENGE TO

A CHALLENGE TO

By Glenn B. Warren, President,

A CHALLENGE TO

The American Society of Mechanical Engineers

A CHALLENGE TO

In a recently reissued book, "Landmarks of Tomorrow,"[1] Peter Drucker points out that whereas in the past we have depended to a very great degree upon the chance inspiration of genius for making our innovations, one of the characteristics of this modern age is that we see a need, and then plan how we can organize to bring forth the innovations that will meet that need. He states that: "Innovation, as we now use the term, is based on the systematic, organized 'leap into the unknown.' Its aim is to give us new power for action through a new capacity to see, a new vision. Its tools are scientific; but its process is of the imagination, its method the organization of ignorance rather than that of known facts.

"But innovation is more than a new method. It is a new view of the universe, as one of risk rather than of chance or of certainty. It is a new view of man's role in the universe; he creates order by taking risks. And this means that innovation, rather than being an assertion of human power, is an acceptance of human responsibility."

This can very well be one of the broad functions of an engineering society, composed as it is of outstanding individuals who can easily visualize the needs, and visualize the way they may be met, and frequently can put their finger on those who can meet them.

Recently I reviewed titles of all of the papers presented during the past year at at least six meetings, and some to be presented this year. I was struck in many cases with the way in which we are doing just this. There are other areas to which this method could be applied.

With respect to the Research Committee

In connection with Everett Barber's report of the Research Executive Committee (MECHANICAL ENGINEERING, February, 1959, pp. 48–51) certain measures were discussed which might free the hands of the Research Committee and permit them to go out and seek the publication of many papers dealing with voids in our basic information. A special committee of the Board on Technology has investigated this matter. The recommendations made were approved by Council at Detroit and are in effect.

In support of the feeling that much of this information remains unpublished, James R. Killian, Jr., stated at the recent meeting of the American Association for the Advancement of Science that: "Approximately 100,000 research reports (published annually) remain outside the normal channels of publication and cataloguing."

In this connection, it has been pointed out that the over-all amount of research work in our fields of effort must be several hundred times that which is being done under ASME auspices, and that we should seek to have as much of this published as possible and desirable.

With respect to the Petroleum and the Oil and Gas Power Divisions

Air pollution is a matter in which more work should be encouraged, although there is need to decide how and by whom it should be done.

If certain figures on fuel consumption, published a few years ago by E. G. Bailey, are prorated to present conditions, it is found that the fuel consumed by all electric-power central stations (including the equivalent fuel consumption of hydroelectric plant output) would cost about $\$1^1/_2$ billion per year. The retail cost, before taxes, of fuel for automotive vehicles would be about $12 billion per year—in other words, about 8 to 1. Yet, the enormous amount we and others are spending on atomic-power development is aimed at saving the smaller of the foregoing.

Much of the smog over our large population centers is ascribed to unburned motor fuels. The remedy thus far

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[1] Harper & Brothers, New York, N. Y., 1959.

Based on an address presented at the Technology Executives Conference, Arden House, Harriman, N. Y., February 8–10, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

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In this keynote address, ASME President Warren calls for a refinement and improvement of what is already being done to foster and encourage creativity and innovation in the areas of the Research Committees and Professional Divisions.

A keen analysis of many current engineering problems provides specific examples of the ways in which the Society can meet these needs.

is directed at the development of a catalytic afterburner which will complete the combustion of the fuel now discharged unburned from the engine exhausts. This is probably 20 per cent of the total. Stated in another way, $2½ billion is now spent annually for fuel which is not doing a useful job and which requires expensive treatment before being discharged into the air.

Most of the development on the automobile engine to date has been in the direction of higher horsepower and better performance with the resulting gain in economy largely eaten up by the necessity for running the engine most of the time at a smaller percentage of its full-load capacity. The automatic choke and automatic transmission have been responsible for great additional losses.

While the swing toward smaller cars and back to gear shift and overdrive is a partial remedy, the great distances in this country and the preference of our people for long, safe, and comfortable drives on vacations will probably continue to favor the larger automobile. Perhaps a light, low-cost, semidiesel, spark-ignition injection engine and a more efficient transmission system are the needs.

Whether or not these are ASME jobs needs to be considered. ASME has an Oil and Gas Power Division and is interested in preventing smog, and this is certainly a mechanical-engineering problem. Perhaps this should be a joint effort with the Society of Automotive Engineers to spur interest in such a development or other developments aimed in this direction.

With respect to the Fuels, Petroleum, Nuclear Engineering, and Power Divisions

Underground hydrogen or fusion-bomb explosions, in addition to offering the possibility of steam-generated power, may make gas and oil available from deep and thick shales and oil sands whose leanness precludes economical exploitation by present methods. If it does, the present availability of low-cost liquid and gaseous fuel resources will increase manyfold. Not only will availability of energy in conventional form be greatly increased, but the dependence of the Western world on the Middle East oil reserves could be relieved materially, and possibly provide a powerful stimulant toward a peaceful settling of many of our problems.

With respect to the Process Industries, Power, and Gas Turbine Power Divisions

There are whole areas dealing with the integration of various power-producing methods and heat sources in the rapidly developing process-industries area which are as yet imperfectly covered. Our Process Industries, Power, and Gas Turbine Power Divisions might well be interested. Much has been done here already, and although new developments are to some extent dormant at the moment because of economic conditions, the technical foundations are probably being laid for future implementation.

With respect to the Metals Engineering Division

Many papers of importance have recently been published in this area, including the re-presentation and publication of the Institution of Mechanical Engineers Symposium on Fatigue, and numerous papers on the properties of large forgings. The effect of temperature on metals is, of course, continually under scrutiny, as well as that of corrosion and other environmental and service factors, under the new conditions which are being met.

However, what we can do now and in the future, in almost every mechanical field is to a very great extent determined by the limitations of our materials. There needs to be close collaboration between the mechanical engineer—particularly the designing engineer—and the metallurgist or the metallurgical engineer.

Such properties as are influenced by both high and low temperatures, by radiation exposure, by the size factor—on which we have been getting more information recently—by fatigue and the effect on fatigue strength of stress concentrations and internal stresses all need to be considered. This is particularly true of those internal stresses which can be introduced with beneficial results in certain ways, and the mysterious properties of internal damping and how it may be obtained in materials. Only in recent years have we begun to understand the toughness factor of materials and its importance. We have only imperfect means of measuring this toughness, such as the level of the Charpy transition temperature.

In connection with prestressing, our ignorance and lack of use of the beneficial gains to be obtained by employing it with highly stressed components is very puzzling in view of the fact that the ordnance engineer has used the principle for years in building sound gun barrels for large guns.

Apparently only one of the 80 or so papers on fatigue presented at the I.Mech.E. Symposium on Fatigue and published jointly with ASME dealt with the effect of residual stresses on fatigue. The conclusion of this paper was: "Lack of specific knowledge in this field limits the efficiency of the utilization of engineering materials. The gradual development of new information about these unharnessed trapped forces increasingly reveals how important they are. To establish the correlation between fatigue properties and such complex residual-stress distributions as come into being because of various processing operations such as heat-treatment, machining, and grinding, and so forth, is one of the major problems." Actually, these residual stresses can be made to either decrease or increase the life and safety of a machine if handled in one way or another.

With respect to the Heat Transfer Division

This Division has been extremely active, but in the area of nuclear-power engineering a whole new intensity of heat transfer is being reached, and much in this area has, as yet, been unpublished. A great deal of it is being released, or will be released, as a result of the policy of declassifying much of the information dealing with the peaceful uses of atomic energy. ASME should be the vehicle for the publication of much of this material.

With respect to the Railroad Division

The railway art is an old one and radical innovations are very difficult to come by compared to the rate of innovation and improvement in air and highway transportation. On the other hand, any system of technology which slows down its rate of innovation is inevitably overtaken sooner or later by something else.

It would be a tragedy indeed for this country if our railway system, which is the most efficient means of transportation of passengers and goods over land that has ever been devised, should be superseded by air and road transportation of much lower basic efficiency. The justice of the current thinking with respect to the unfairness of the tax situation to which the railroads have been subjected, and the justice of the plea for relief or subsidy are fully recognized. Properly applied, this relief can produce more results from the standpoint of transportation than an equivalent amount of money spent in producing bigger airports and more and better high-speed highways. But, if the railroads do not begin to match the technological advance of their competitors, the situation will simply get worse.

There have been a number of significant improvements in freight handling, particularly the piggyback car. It may appear radical from the safety standpoint to suggest automatic operation of passenger trains. Yet, if we can run elevators, machine tools, and power plants, take-off, fly, and land airplanes and guided missiles automatically, we should be able to do this with the commuter trains and subway trains, or at least with one man per train instead of the five required at present. In fact, a recent newspaper account indicates that automatic operation of the New York City subway shuttle trains may be a reality in the near future. The Railroad Division of ASME might make a major contribution by stimulating and encouraging thinking along some of these radical lines.

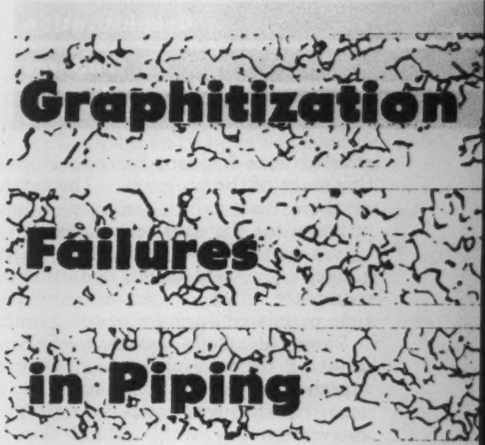
With respect to the Management Division

There are two suggestions pertaining to the Management Division, both of which have already been discussed with the Executive Committee. First, the effectiveness of their service will be greatly enhanced if they can continue and extend their recent practice of preprinting or publishing a larger number of their papers. Second, they could profitably concentrate on the problems of engineering management, particularly the problems associated with the transition of engineers from individual engineering projects and responsibilities to engineering management, and the transition in later years into general management.

In conclusion

This has not been intended as an exhaustive listing, but rather as illustration of some of the things which might be done by ASME to encourage innovation and creation in the fields of interest within the Society's sphere.

Some people have characterized the cold war as a "technological Olympic game." In this, our principal weapon is continued innovation. It is our responsibility and one of the greatest services which we can render to our country and the West, and the things which we hold dear, to see that we do not neglect this area. ●



Graphitization Failures in Piping

By J. B. Nuchols[1] and J. R. McGuffey[2]

Union Carbide Nuclear Company,
Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.

Two major graphitization failures in the high-pressure piping at the Oak Ridge Gaseous Diffusion Plant Power Station indicate the potential hazards for the power industry where comparable piping systems are still operating with carbon-molybdenum steel.

In September, 1957, the Oak Ridge Gaseous Diffusion Plant Power Station experienced two unexpected major graphitization failures in the carbon-molybdenum steel high-pressure main steam piping. The pipe had been in operation in excess of 100,000 hr at 1325-psi 935-F design conditions since the station began operation in April, 1944. Three boilers each rated at 750,000 lb of steam per hr are connected by leads to a common 16-in. distribution header which distributes steam to 14 turbines, Fig. 1.

Prefailure Graphitization Sampling Program

Since few mill tests were available on this wartime piping, an extensive sampling program to evaluate the extent of graphitization in the carbon-molybdenum steel piping system was started in 1949 after 33,000 hr of operation.

Pipe Joints. Samples, in 1949, from five pipe-to-pipe welded joints showed only scattered, small, graphite nodules in the pipe heat-affected zones. An additional 16 random boat-shaped samples removed from other pipe joints during the next 8 yr indicated that the graphitization of the pipe was progressing at a moderate rate with no great loss in ductility. In order to retard the graphitization, 71 pipe joints were normalized at 1700 F during this period.

Valve-to-Pipe Joints. In 1951, after 49,000 hr of operation, six samples removed from valve-to-pipe welds revealed that the two nonreturn valves and four block valves were graphitizing at a moderate to rapid rate. The graphite was classified as medium-to-large nodules in line form. These joints were normalized as techniques for flame gouging the weld and graphitized heat-

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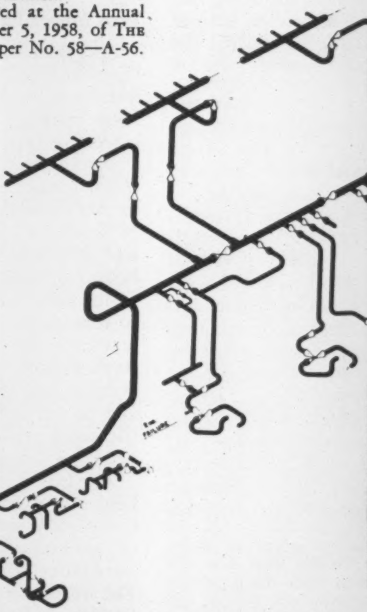
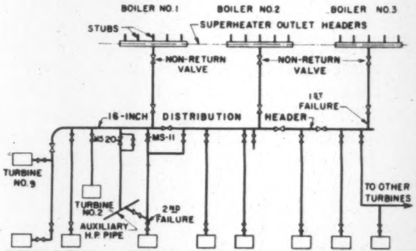
[1] Assistant Production Division Superintendent, Power.

[2] Superintendent of Metallurgical Engineering Department.

Contributed by the Power Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of The American Society of Mechanical Engineers. Paper No. 58—A-56.

Fig. 1 Main steam piping system—three boilers each rated at 750,000 lb per hr of steam are connected by leads to a common 16-in. distribution header which distributes steam to 14 turbines


FIRST FAILURE
TO OTHER TURBINES
2nd FAILURE


BOILER NO.1
BOILER NO.2
BOILER NO.3
STUBS
SUPERHEATER OUTLET HEADERS
NON-RETURN VALVE
NON-RETURN VALVE
1ST FAILURE
16-INCH DISTRIBUTION HEADER
MS20
MS-11
TURBINE NO.9
TURBINE NO.2
2ND FAILURE
AUXILIARY H.P. PIPE
TO OTHER TURBINES
TURBINE NO.10
TURBINE NO.1
TURBINE NO.3
TURBINE NO.4
TURBINE NO.5
TURBINE NO.6
TURBINE NO.7
TURBINE NO.8
MAIN STEAM PIPING

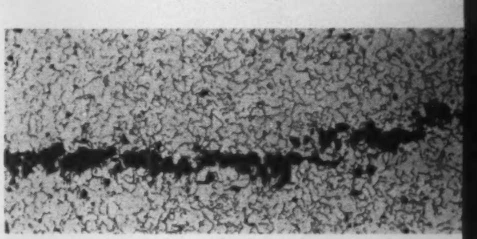


Fig. 2 Graphitization of stubs leading from elements which operated above normal temperatures developed leaks through zones of slip-plane graphite, well away from the welds

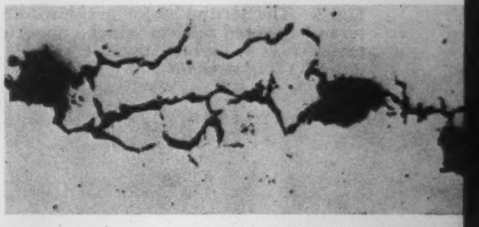


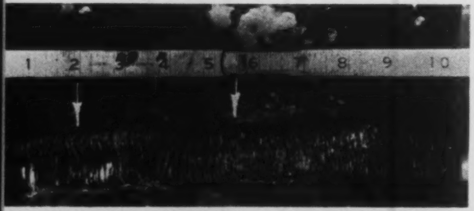
Fig. 3 One of a family of cracks observed in the header between the stub holes some of which progressed completely through the header wall. These were caused primarily by stress rupture although graphitization was a contributing factor.

affected zone had not been developed at the Station at this stage of the program. The extent of graphitization of these cast valves strongly influenced the remedial program for the next several years. By June, 1957, ten valves had been replaced, four valves had been flame gouged and rewelded, and 18 normalized. It was planned to replace all of the carbon-molybdenum steel valves as time permitted during scheduled boiler overhauls.

Superheater Outlet Headers and Stubs. Small steam leaks resulting from graphitization were experienced in the superheater outlet-header stubs in 1951. These leaks occurred through zones of slip-plane graphite well away from any welds in the $2^1/_8$-in-diam pipe stubs which connect the superheater elements to the superheater outlet header of the No. 1 Boiler, Fig. 2. This type of graphitization was limited to the stubs leading from elements which operated at above normal temperatures due to the heat pattern formed by the tangential firing in the boiler.

During the removal of one of these stubs from the header, a family of cracks was observed in the header between the stub holes. The cracks which progressed in some cases completely through the header wall were caused primarily by stress rupture; each crack, however, traveled through closely connected gross, graphite nodules, so graphitization was a contributing cause of failure, Fig. 3. The defective areas were chipped out and temporary repairs made by filling in the header ligaments with weld metal.

The location of the graphitized stubs, headers, and nonreturn valves constituted a serious hazard in case of sudden rupture as it would be impossible to control the steam release. Consequently, chromium-molybdenum steel replacement stubs, headers, pipe between the headers and the nonreturn valves, and the nonreturn valves were procured and installed on the three boilers; the new components were installed in 1952, 1953, and 1955. Subsequent studies of the removed carbon-molybdenum steel components indicated that additional graphitization difficulties probably would have been experienced had the material remained in service for longer periods of operation.



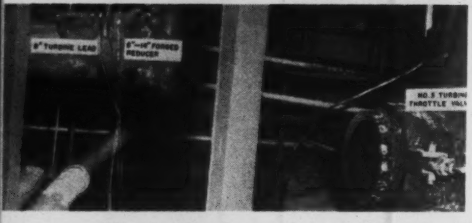


Fig. 4 The first major graphitization failure occurred when an 8-in-long crack opened in the 12-in. boiler lead near the 16-in. header with a sizable release of steam since the pipe was operating at full pressure

Fig. 5 The second major graphitization failure was the rupture of a forged reducer which connected the 8-in. steam lead to the No. 3 Turbine throttle valve. The line severed and moved 3 ft upstream.

Castings and Forgings. During the scheduled outage of the No. 1 Boiler in the summer of 1957, the sampling program was extended to include pipe-to-equipment welds in components such as cast strainers, inlet ells to two throttle valves, and two throttle-valve steam-chest assemblies. The heat-affected zones in these components had moderate to severe graphitization as evidenced by graphite nodules in a line and 65 to 12-deg bends.

Samples were also removed from four forged fittings connecting the 16-in. distribution header to the boiler and turbine leads. The results were quite variable; one fitting had no graphite and a 90-deg bend, the other three had 50, 30, and 38-deg bends, and graphite nodules in line form. The 50-deg bend in one of the fittings is of particular significance as a comparable fitting at the other end of the header constituted the first major graphitization failure three months later.

The heat-affected zones in these castings and forgings were normalized or gouged out and rewelded, and normalized before the No. 1 Boiler was returned to service.

During the period 1949 to June, 1957, 55 joints or approximately 20 per cent of the total had been sampled one or more times, several critical components such as the superheater outlet headers and the nonreturn valves had been replaced, and 93 joints had been heat-treated or replaced with new weld metal. In no case had the ductility been less than 30 deg on the basis of bend tests.

Two Major Failures

At 7:55 p.m. on September 4, 1957, three months after the scheduled inspection outage of the No. 3 Boiler, an 8-in-long crack opened in the 12-in. boiler lead near the 16-in. header, Fig. 4, with a sizable release of steam, since the pipe was in normal operation at full pressure and temperature. The charts indicated no operational conditions existed which would cause stresses by thermal or mechanical shock to the system before or at the time of fracture. The crack was caused by graphitization and was located in the heat-affected zone of a forged hot-upset fitting connecting the 12-in. boiler lead to the 16-in. distribution header. Immediate steps were taken to remove the No. 3 Boiler and associated turbines from service. By 8:10 p.m., the boiler had been removed from service and the section of piping isolated from the system by means of sectionalizing valves. Prompt and proper action by the operating personnel in reducing the load without inducing high thermal stresses prevented a complete rupture.

The failed joint was removed and the following metallurgical observations made: the crack had progressed completely around the inner periphery; only a $^1/_4$-in. of uncracked metal near the outer surface in three quadrants of the pipe prevented a complete rupture. The heat-affected zone at the other end of the fitting was so severely graphitized that the bend tests showed no ductility. As described previously, a sample removed a few months earlier from a comparable fitting on the other end of the header revealed acceptable ductility and slight-to-moderate nodular graphite; thus, there was no metallurgical evidence to predict the need for immediate remedial action to prevent a failure. Subsequent testing of six samples removed from other fittings near the failure illustrated the same wide variation in results; one had no graphite and withstood a 90-deg bend, while the remaining five had 45 to 0-deg bends.

On the basis of the metallurgical studies of the failed fitting, it was decided to remove the No. 2 Boiler from operation as a precautionary measure. The No. 1 Boiler was kept in service since extensive repairs had been effected in critical areas during the 1957 outage.

On September 17, 1957, with only the No. 1 Boiler in operation and repairs in progress on the No. 3 Boiler piping, the second major graphitization failure occurred completely shutting down the Station. At 6:16 p.m., as the turbine was being prepared for service, a forged reducer which connected the 8-in. steam lead to the No. 3 Turbine throttle valve ruptured with a loud report and a voluminous release of steam. The line severed completely and moved upstream 3 ft from the valve, Fig. 5. Emergency shutdown functions were performed immediately. All but one of the 36 employees in the building were able to evacuate by the nearest exit; one man was trapped for a short time on the sixth floor before being rescued. Again circumstances were such at the instant of failure that there were no injuries.

Events leading to the rupture were as follows: At 5:00 p.m. preparations were made to place the turbine in operation. This consisted of warming up the lead between valve MS-11 (the first block valve on the turbine lead) and the turbine throttle valve by pressuring the lead to operating pressure through the 1-in. bypass line on valve MS-20, Fig. 1. By 6:05 p.m. the lead was at 950 psig and 820 F, and preparations were made for equalizing the pressure across MS-11. At 6:14 p.m. the pressure was between 1200 and 1250 psig and the temperature was approximately 795 F. At 6:15 p.m., MS-11 was opened applying normal 1300-psig steam at 925 F to the lead. One minute later, the lead ruptured in the heat-affected zone at the large end of the reducer near the throttle valve. The microstructure showed a typical "eyebrow" graphitization in the failure area and will not be described further except to note that the other end of the fitting was at the point of failure. It is significant that the same type of fitting, leading to a comparable turbine sampled 3 days previously in conjunction with work on the No. 3 Boiler piping, had shown 90-deg bends with only scattered graphite nodules.

Repair Procedure for No. 3 Boiler Piping

In order to safely return the piping associated with the No. 3 Boiler to service as soon as possible, it was deemed necessary to remove a sample from every component in this portion of the system. Thus, to avoid missing a joint, the insulation was completely removed; this procedure resulted in the location of a weld not shown on the drawings. A total of 79 joints was sampled and evaluated as follows:

1 The 16-in. distribution header had chain graphite in the weld heat-affected zones as well as slip-plane graphite in areas away from welds; the ductility varied from 35 to 90 deg. While the graphite in the heat-affected zone could be removed by gouging, the slip-plane graphite could not because of uncertainty as to its location. Four of the five fittings attached to this portion of the header had interconnected nodules or eyebrow-type graphite. It was therefore, decided to replace this portion of the header and associated fitting.

2 There were three exceptions to the over-all uniformity of the main steam piping; these pipes had moderate graphitization with 30, 45, and 55-deg bends while the remaining had scattered small nodules with 80 to 90-deg bends.

3 The small-diameter pipe which operated above 800 F was badly graphitized in restricted weld regions.

4 The Nos. 6, 7, and 8 Turbine throttle valves and associated fittings, and the one steam chest tested had not graphitized to any extent. As a result of the above metallurgical evaluation, the following action was taken to safely return the No. 3 Boiler piping to operation on October 12, 1957: (*a*) The north portion of the 16-in. distribution header and its associated fittings, five valves, and all of the small-diameter pipe and fittings which operate above 800 F were replaced with new chromium-molybdenum steel; (*b*) 46 pipe-to-pipe and pipe-to equipment joints were normalized, and five joints with more advanced graphitization were flame gouged, rewelded, and normalized.

Conclusions

Prior to the first failure, a high level of confidence had been placed in the selective sampling, partial replacement, and remedial repair of the graphitized carbon-molybdenum-steel piping system. The program had been executed in conjunction with scheduled inspection outages to provide for a high plant factor during a period when power requirements were critical. The long-range plans called for steady continuation of the program recognizing that more replacement and/or greater use of the flame-gouging technique might be expected as the graphitization progressed beyond ready repair by normalizing. The first failure during normal operation at full load indicated that the program was inadequate from the viewpoint of both safety and efficient operation. Only a fortunate chain of events and quick, intelligent action by the operating personnel at the time of the failures prevented serious injury and extensive plant damage.

The thorough evaluation made possible during the complete sampling of the No. 3 Boiler piping revealed that there are factors in graphitization which cannot be readily predicted. The variation from 90 deg to less than 5 deg in bend tests removed from apparently identical forgings in comparable locations proved that any unsampled component must be considered a potential graphitization failure.

Complete sampling proved to be quite complex, expensive, and time-consuming, and unless the part was replaced, the corrective action taken was not a permanent cure. For this reason it was decided not to repeat the procedure used on the No. 3 Boiler piping for the remainder of the piping. Accordingly, plans were formulated to systematically replace all of the carbon $^{1}/_{2}$ per cent molybdenum steel in the system with $1^{1}/_{4}$ per cent chromium, $^{1}/_{2}$ per cent molybdenum steel. This replacement was started on the No. 2 Boiler piping; the piping associated with the other two boilers is being replaced in sequence as materials become available.

Acknowledgments. The authors wish to thank D. B. Janney, T. C. Wilson, W. W. Latham, and J. W. Edwards for assistance in preparing this report. ●

Three Models for Three Ranges...

INTERCONTINENTAL

...The

By J. E. Steiner, Assistant Chief of Preliminary

BOEING is now producing a family of jet transports, each tailored to suit the needs of a particular route situation.

Some years ago, early in our jet-transport efforts, a general argument existed as to whether a single airplane design could efficiently do both the North Atlantic and the domestic United States jobs. Our studies have indicated that the efficiency of such a multipurpose design is open to question. In fact, the operating profit of the major airlines is so very small that the use of the correct-sized airplane on a given route is almost an economic necessity for airline survival.

Figs. 1 and 2 show the effect on a medium-range operator of using an airplane designed for a longer route. In Fig. 2, it is shown that the use of a transocean aircraft on a medium-range route could almost entirely eliminate the profit per dollar invested.

Operating the wrong-size airplane on a given route can substantially increase costs. However, operating a variety of different-sized airplanes can also increase costs. The cost differential caused by having a split fleet may be greatly minimized by having a family similarity between the aircraft. Family similarity or commonness has two aspects of cost saving: Those to the manufacturer enabling a lower price, and those to the operator in day-to-day operating costs.

A Family of Jet Transports

The data used in this discussion are based on the existing Boeing family of three different but related airplanes. This series of jet transports has been designed with the idea of similarity coupled with size requirement. The Model 720 is a short to medium-range airplane; the 707–120 is a medium to long-range airplane; and the 707–320 is a long-range intercontinental transport. Fig. 3 shows the general characteristics.

In designing such a family, more than range, of course, must be considered. For example, the field lengths available to a medium-range airplane are in general shorter than those available to a longer-range aircraft. Model 720 has the same wing area as the 707–120 while the 707–320 has about 20 per cent more wing area. Characteristics shown are of course for average conditions. For example, the passengers to break even have been selected at moderately long ranges for the type concerned. Had a very short range been chosen for this comparison, the increases would have been much greater.

The structural relationships of these three aircraft types are shown in Fig. 4. Cross-hatched areas indicate the same structure, and white areas indicate structural components peculiar to the type involved. It should be noted that the nose and body cross section has been maintained identical, an item which is most important in gaining the advantages of such a related family of aircraft. Center-section structure for Model 720 and 707–120 is similar while the center section of the 707–320 has dimensional differences as well as gage changes.

Structural layout and practices are the same for all models so that the same structural tests are, in general, applicable. The use of such similarity and the larger over-all number of aircraft which the family concept is expected to make possible have resulted in our ability to conduct an enormously complete set of structural tests, probably the most complete test run on a type.

Landing Gears Must Vary

Fig. 5 shows the main landing-gear relationship for each of the three types of aircraft. While nearly identical geometry has been maintained, major items such as oleodiameter and truck length have been changed. This situation results in economies of manufacture, and in similar testing and similar training of maintenance crews. Optimization of empty weight and design for the particular route involved has required a fairly low interchangeability of actual landing-gear parts.

Fig. 6 shows the typical Boeing power-plant installation. It has been necessary to use different engines in each of the three airplane models shown. Model 720 basically uses the Pratt & Whitney JT3C-7 engine, Model

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Based on a paper contributed by the Aviation Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of The American Society of Mechanical Engineers.

MEDIUM-RANGE
TRANSCONTINENTAL

BOEING 707

Design, Boeing Aircraft Company, Renton, Wash.

Operators are keenly aware of the need for optimized airplanes. This paper discusses the special airline advantages of related airplanes, and describes the new Boeing "family" series of jet transports.

707–120 uses a higher thrust version of the same engine with water augmentation, and Model 707–320 uses the Pratt & Whitney JT4 engine having a larger size and thrust. In addition, we produce the Model 707-320 airplane with an alternate engine, the Rolls Royce Conway C010, and similar alternates have been, and are being, considered for the other models.

Notwithstanding the difference in engines, it has been possible to maintain a considerable commonness in accessories and certain structural elements. For example, the turbocompressor and the constant speed drive are identical for all installations. The nacelle cowling and struts on the 720 and Model 707–120 are manufactured on common tooling. In addition, similar layout and design practices permit use of some common testing for the manufacturer and of much common maintenance training for the operator.

Standardized Fluid Systems

Fig. 7 briefly diagrams the hydraulic system. This system is virtually identical for all models and at least a 90 per cent interchangeability of components has been obtained. The system is designed for 3000-psi operating pressure using Skydrol 500 hydraulic fluid. Fluid pressure for this system is supplied by a variable-displacement piston-type pump which is mounted on each inboard engine. An auxiliary variable-displacement piston-type pump is provided for the inboard spoiler and speed brakes and in the case of the 707–320 and 720 for the rudder-boost system. This pump is driven by an a-c electric motor.

As for the fuel systems, it has been possible to design all three with the same boost pumps and similar or identical components, maintaining approximately 75 per cent commonness in fuel-system parts.

An independent fuel system is provided for each engine and interconnected by a manifold line so that fuel may be delivered from any tank to any and all engines. The fuel tanks are built integral with the structure, with the exception of the center tank which utilizes bladder cells. Fuel-tank sealant in all fuel-system components

COST

MEDIUM RANGE OPERATOR USING	MEDIUM RANGE	TRANS CONTINENTAL	INTER CONTINENTAL
SUFFERS INCREASE IN TRIP OPERATING COST	0	17%	37%
OR AN INCREASE IN SEAT MILE COST	0	7%	15%

Fig. 1 The effect of using, on a medium-range route, an airplane designed for a longer route. First, the cost per mile where the additional seating of the larger plane cannot be utilized. Second, seat-mile-cost, applicable to a route where the seats of the larger plane can be filled.

PROFIT

MEDIUM RANGE OPERATOR USING	MEDIUM RANGE	TRANS CONTINENTAL	INTER CONTINENTAL
REDUCTION IN PROFIT/PASS. MILE	0	18% AT 1500 N. M.	36% AT 1500 N. M.
REDUCTION IN PROFIT/YEAR/$ INVESTED	0	52% AT 1500 N. M.	83% AT 1500 N. M

65% LOAD FACTOR

Fig. 2 The data of Fig. 1, translated into airline profit. Based on a 65 per cent load factor, at 1500 nautical miles, the use of a transocean aircraft on a medium-range operation could almost eliminate the profit per dollar invested.

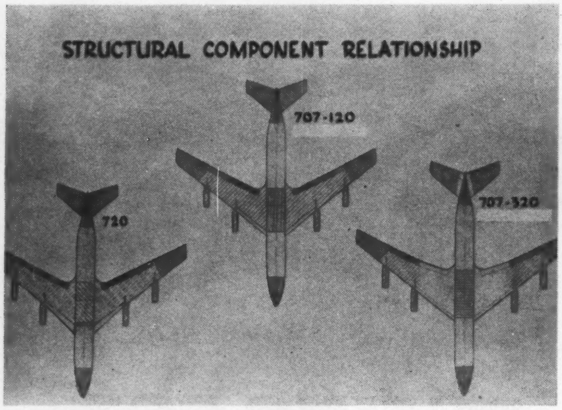
	720 MEDIUM	707-120 TRANS CONTINENTAL	707-320 INTER CONTINENTAL
RANGE APPROX PERCENT	REF	+ 25%	+ 60%
TAKEOFF WEIGHT	REF	+ 25%	+ 50%
STRUCTURAL WEIGHT	REF	+ 4,000 LBS.	+ 12,000 LBS.
WEIGHT EMPTY	REF	+ 8,000 LBS.	+ 22,000 LBS.
APPROX PASSENGERS TO BREAK EVEN	REF	+ 15%	+ 35%

Fig. 3 The Boeing "family" of jet transports. Model 720 has the same wing area as the 707-120, while the 707-320 has about 20 per cent more. Structural layout and practices are the same for all models.

Fig. 4 The structural relationships of the three aircraft in the "family." Cross-hatched areas indicate the same structure; white areas indicate structural components peculiar to the individual type. Wing structure other than the white and cross-hatched areas is similar but contains structural gage changes to permit variations in structural weight and strength.

Fig. 5 The main landing gear, with its nearly identical geometry for all three planes. Economies reach all the way to the training of maintenance crews. Here, the necessity for optimizing empty weight results in a comparatively low standardization of parts.

Fig. 6 Each of the three planes requires a different model of Pratt & Whitney engine; and alternate engines are offered. Nevertheless, it has been possible to effect considerable standardization in accessories and structural elements



is designed for both jet fuels and gasoline. All fuel valves are d-c electrically operated. All boost pumps are a-c electrically powered. Closure of one valve on each engine will shut off the flow of fuel and is controlled by the engine emergency control for the engine concerned. A fuel-dump system is installed which is controlled by three valves on each side of the airplane, one for each tank. Fuel is jettisoned by gravity flow from each tank, or combined flow from all tanks.

Airplane lateral control is by inboard and outboard ailerons and spoilers. The outboard ailerons function only at low speeds and are automatically locked in neutral when the wing flaps are retracted. When the flaps are extended, the outboard ailerons are operated directly by the aileron bus system. The inboard ailerons are operated through control tabs. The spoilers are operated by hydraulic actuators controlled by valves arranged in a mechanical position feedback system so that a given movement of the control wheel gives a proportionate amount of deflection of the spoilers.

Lateral-Control Surfaces Identical

This system is used on all three models of Boeing jet transports. The lateral-control surfaces on all models are identical. Also a high degree of commonness exists in the detail design of parts in the lateral control itself.

Rudders are operated by control tabs for travel during normal operation. On the 707–320 and 720 the rudder is hydraulically assisted during extreme ranges of travel. The assisted rudders are equipped with provisions for fuel proportional to air-speed and surface deflection. Rudder trim is attained by a control tab operated by a cable system to the control stand.

The rudder control system on all three models is virtually identical forward of the vertical tail. Basically, the same vertical fin is used on all three models.

The elevators are manually operated through control tabs by a dual cable system. The system is identical on all three models with the exception of the installation differences in the horizontal tail on the 707–320.

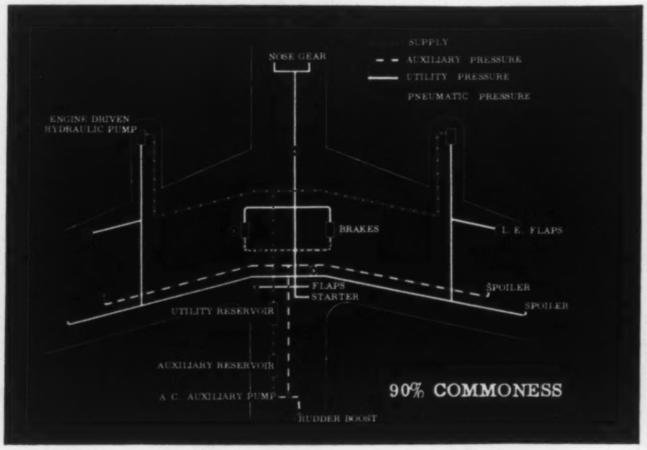
The wing-flap system consists of two inboard flaps, two fillet flaps, and two outboard flaps. The flaps are actuated by ball-bearing screws driven through gear boxes and transverse torque tubes. The inboard and fillet flaps are interconnected by a torque tube and driven by one hydraulic motor. The outboard flaps are interconnected by a torque tube and driven by a second hydraulic motor. Each motor is operated by an individual valve connected by a common cable system to a control lever on the control stand. In the event of complete hydraulic failure, emergency operation of the flap system is accomplished by electric motors controlled by switches in the cockpit.

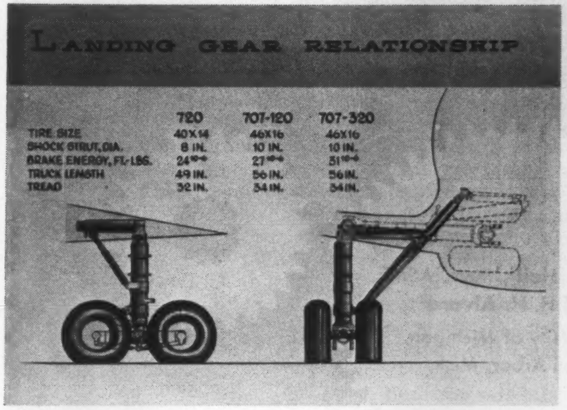
Flaps are the same on all three models with the exception of the inboard flap on the 707–320 which is similar in design. The flap-drive system is the same on all models with the exception of difference in actuators and drive systems in the wing root and wheel well on the 707–320.

Saving the Airlines' Money

As noted earlier in this discussion, the airline operator can lose substantial amounts of money by operating an airplane on a route for which it is not well suited. On the other hand, there are substantial costs in operating a

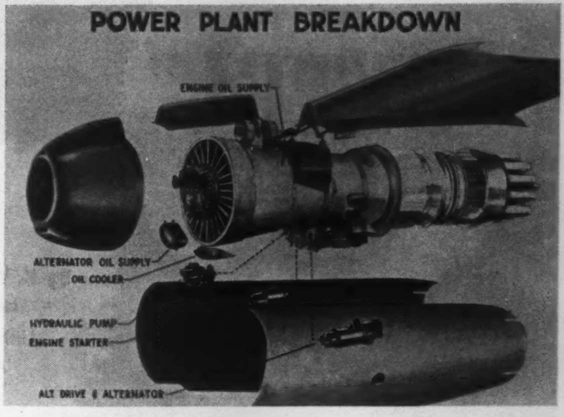
Fig. 7 The hydraulic system, virtually identical for all models, and more than 90 per cent interchangeable in its components. Similarly, in the fuel system, approximately 75 per cent commonness has been attained





LANDING GEAR RELATIONSHIP

	720	707-120	707-320
TIRE SIZE	40X14	46X16	46X16
SHOCK STRUT, DIA.	8 IN.	10 IN.	10 IN.
BRAKE ENERGY, FT-LBS.	24^{10-6}	27^{10-6}	31^{10-6}
TRUCK LENGTH	49 IN.	56 IN.	56 IN.
TREAD	32 IN.	34 IN.	34 IN.



number of different unrelated aircraft designs. A list of airline advantages of operating a series of related airplanes instead of unrelated ones includes the following:

Spares interchangeability.
Maintenance procedure.
Safety.
Ground equipment.
Training equipment.
Crew training.

Each of these items could be the subject for careful investigation and extensive discussion. The financial outlay involved is extremely large and the advantage, for example, in maintaining virtually identical cockpits can mean the difference of being able to operate the right airplane for the route involved and being financially incapable of doing so. As all modern airlines know, the cost of electronic cockpit trainers and of securing the required flight-crew airplane time has become extremely burdensome.

Approximately 60 per cent of parts interchangeability has been maintained for these aircrafts. This same approximate 60 per cent number pertains even if greater dissimilarity of design is used. For example, a 707–420 powered by a Rolls Royce Conway engine would still retain approximately 60 per cent spares interchangeability with Model 720 powered by Pratt & Whitney JT3C-7 engines.

Fig. 8 presents the per cent improvement in profit per passenger mile over a range of airline route systems obtained by using a family of similar airplanes over using unrelated airplanes. Such a family, of course, would normally be composed of either two or three different types of airplanes. This profit parameter is plotted as a function of the fleet composition.

As the system market or route composition in terms of per cent long range is reduced, it will be necessary to use a different type of aircraft or suffer the losses shown earlier in this discussion. This introduces a split fleet and imposes certain economic penalties. As the amount of fleet splitting in terms of fleet composition for per cent medium-range aircraft is increased, the penalty associated purely with fleet splitting becomes greater, and it is then that the considerable amelioration of this penalty obtained with a family aircraft shows its advantage over "unrelated" aircraft.

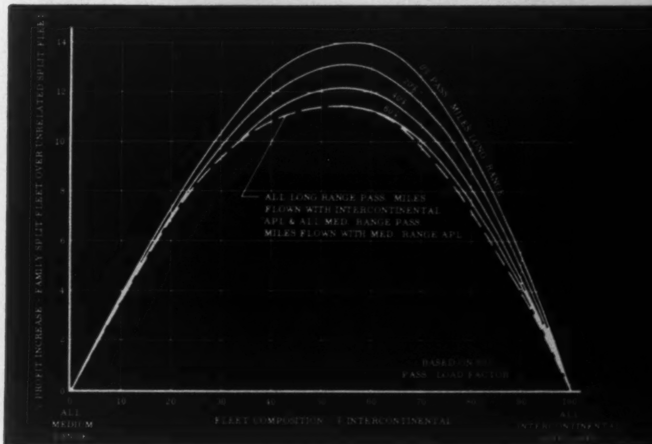
The Differecne Could Be Critical

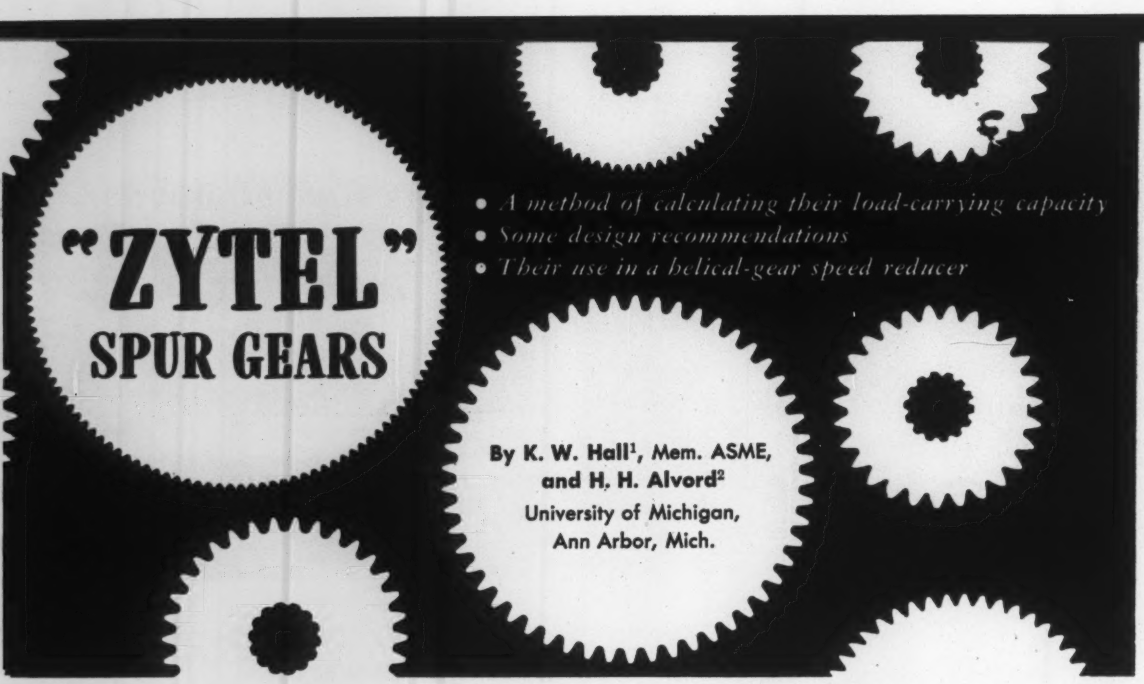
If the fleet composition is composed of 50 per cent intercontinental and 50 per cent medium-range aircraft, and two related or family aircraft such as the 720 and 707–320 are used rather than two unrelated aircraft, the entire fleet will have an improvement in profit per passenger mile of more than 11 per cent. Such an 11 per cent improvement could easily mean the difference between airline survival and failure.

Certain airlines have run studies showing that it is as cheap to operate a long-range aircraft on a medium-range route as it is to buy an unrelated new medium-range type. This situation, of course, is a comparison of two uneconomical methods. A much preferable alternate would be the operation of two related types.

While we are aware that different assumptions will produce slightly different results and that any such discussion as this must necessarily be oversimplified, we believe the underlying philosophy of the family concept in transport design is basically sound. ●

Fig. 8 The results of a study of the effect of operation of a family of similar airplanes versus unrelated airplanes, over particular routes. The curves show the profit increase generated by using related airplanes.





"ZYTEL" SPUR GEARS

- *A method of calculating their load-carrying capacity*
- *Some design recommendations*
- *Their use in a helical-gear speed reducer*

**By K. W. Hall[1], Mem. ASME,
and H. H. Alvord[2]**
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A METHOD of calculating the load-carrying capacity of spur gears of Zytel has been established as part of the work being done at the University of Michigan to establish reliable design methods for gears made of this material. This continuing project is being sponsored by the Polychemicals Department of E. I. du Pont de Nemours and Company.

Material

Zytel, a nylon resin manufactured by du Pont, is thermoplastic and is supplied in the form of granulated powder for molding by conventional molding techniques.[3] The molded material has relatively light weight, is rigid and tough, has a low coefficient of friction, and good resistance to abrasion.

The physical properties, Table 1, are considerably affected by temperature. For example, Fig. 1 shows how the yield strength decreases with increase in temperature, while the impact strength increases. The physical properties are also somewhat affected by the moisture content of the molded material. Table 1 is for material which has been conditioned to have $2^{1}/_{2}$ per cent moisture by weight. This represents the amount of moisture absorbed at equilibrium, with air at 50 per cent relative humidity and 73 F.

Test Machines

To establish the load-carrying capacity of gears of Zytel, five identical test machines, shown schematically in Fig. 2, were designed and built. These operate on the "back-to-back" or "four-square" principle, with two pairs of gears in each machine loaded against each other. In this way, the driving motor supplies only the power to overcome friction and windage in the machine.

The gears to be tested are mounted on hollow shafts supported in ball bearings. Two steel torsion bars connect the hollow shafts. A friction coupling at the right end is used to twist the torsion bars, thus providing the desired load on the gear teeth.

The bearing supports for the rear shaft in Fig. 2 are movable, thus allowing various sizes of gears to be tested. Load is applied to the gear teeth by twisting the friction coupling with a system of small wire ropes and weights operating on pulleys. After clamping the friction coupling with the screws provided, the wire ropes are removed to allow the couplings to rotate. Any desired twisting moment can be applied to the coupling by changing the amount of lead shot in the buckets. Each machine is individually driven by a motor through a speed variator, providing a 600 to 5000-rpm range.

Test Gears

A fairly large variety of gears has been tested, many of which were machined from molded disks of Zytel. The teeth of these gears were cut with hobs after the disks had been machined to size, Fig. 3. Pitch diameters of these cut gears ranged from 1.375 to 3.75 in. with diametral pitches of 16, 20, 32, and 48. All but a few had a 20-deg pressure angle and full-depth teeth, with face widths varying from $^{7}/_{32}$ to $^{7}/_{16}$ in. Accuracy limits of the teeth of these gears ranged from AGMA Commercial Class 2 to Precision Class 1, with most of the teeth within the limits of Commercial Classes 2 or 3.

In addition to the cut gears, $2^{1}/_{2}$-in-diam 20-pitch and 32-pitch gears having molded teeth have been tested. These gears also have a 20-deg pressure angle, with full-depth teeth and $^{1}/_{2}$-in. face width. The web which joins the hub and rim is $^{1}/_{8}$-in. thick.

A single-cavity mold, with a ring gate at the hub, was used to form these test gears. The molded 20 and 32-pitch teeth were within the accuracy limits of Commercial Classes 1 and 2, and this accuracy would have been difficult to obtain without a ring-gated mold.

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[1] Professor of Mechanical Engineering.

[2] Associate Professor of Mechanical Engineering.

[3] Zytel 101, which is recommended for mechanical parts, is referred to throughout.

Contributed by the Machine Design Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 58—A-209.

Tests and Results

An extensive life-testing program was first conducted with the machined gears having cut teeth, since variations in gear diameter, diametral pitch, face width, pressure angle, and so on, can be most easily accomplished with cut teeth. Pitch-line velocities ranged from 785 to 3730 fpm, both with and without lubrication of the teeth. In cases some pairs of identical gears ran together; in others, small pinions were used with gears.

During this work, the machines ran 24 hr per day, being stopped only occasionally for visual inspection or to replace broken gears. When a gear failed, that gear and the gear with which it meshed were replaced and this was counted as a single failure. During most of the test work, the teeth were lubricated with oil mist. When no lubrication was desired, the oil-mist system was turned off. The gears were generously lubricated with oil at the start of the no-lubrication tests, but were not lubricated thereafter. Ambient temperatures and humidity were uncontrolled, varying from 68 to 92 F and 29 to 85 per cent relative humidity, while the test work was in progress.

Some of the results obtained with the gears having cut teeth are shown in Fig. 4. Similar but less extensive data were obtained for 20 and 48-pitch gears having cut teeth. The life of the 32-pitch molded gears was considerably greater at any given load than that of the gears with cut teeth. The 20-pitch molded teeth made a relatively poor showing particularly at the higher stresses, which probably resulted from the presence of residual stresses in the rim of most of the molded gears tested and the thin web which did not provide enough support for the rim and teeth at high loads.

TABLE 1 PHYSICAL PROPERTIES OF "ZYTEL" 101 NYLON RESIN WITH 2.5 PER CENT MOISTURE CONTENT AT 73 F

Tensile strength, psi	11,200
Yield strength, psi	8500
Elongation, per cent	300
Modulus of elasticity, psi	175,000
Shear strength, psi	8000
Izod impact strength, ft-lb per in	2.0
Rockwell hardness	R108, M59
Specific gravity	1.14

Evidence of residual stresses can be seen in Figs. 5, 6, and 7 which show failures of some of the 20-pitch molded gears. Rather than failing at the root of a tooth in a typical bending-fatigue failure, these gears failed by breaking through the rim. This type of failure was preceded by the formation of cracks at the roots of the teeth, as shown in Fig. 7. It was not uncommon to have these cracks form at the root of virtually every tooth on the gear after a relatively short period of operation. The gears would then continue to run for a long period, during which one or more of the cracks would progress through the rim to the web. When the crack reached the web, a piece generally broke out to end the test.

When the 20-pitch gears were annealed to remove the residual stresses, the life of the gears was considerably increased. The annealed gears failed at the root in a typical fatigue failure, Fig. 8.

At higher loads there was evidence of distortion of the $^1/_8$-in. thick web of the 20-pitch gears, and it was believed that this adversely affected the life of the 20-pitch

Fig. 1 The effect of temperature on typical physical properties of Zytel 101

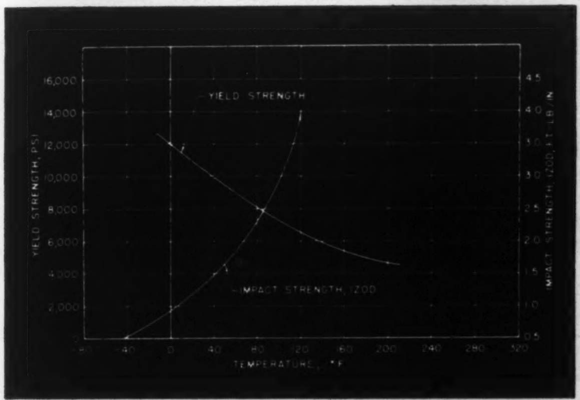


Fig. 2 A schematic layout of the machine used for making the gear tests

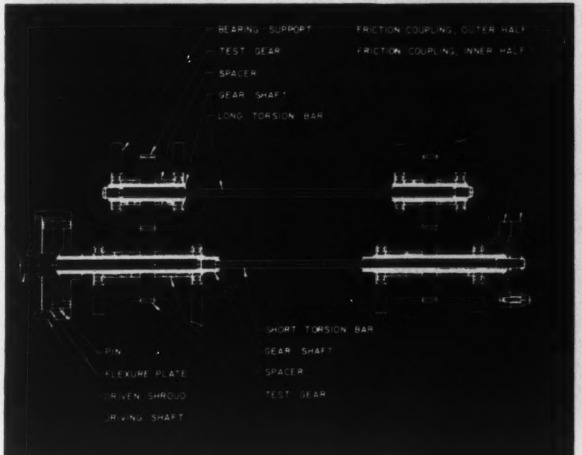


Fig. 3 An assortment of Zytel test gears with hob-cut teeth

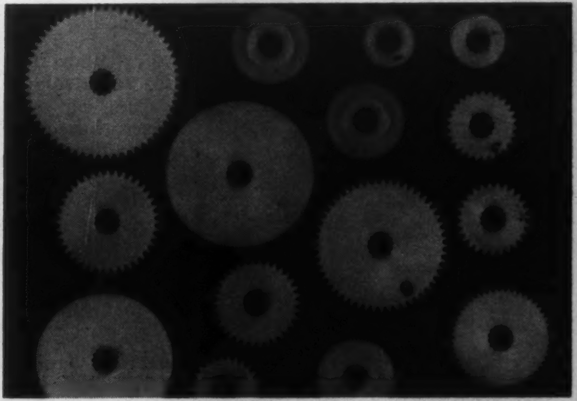
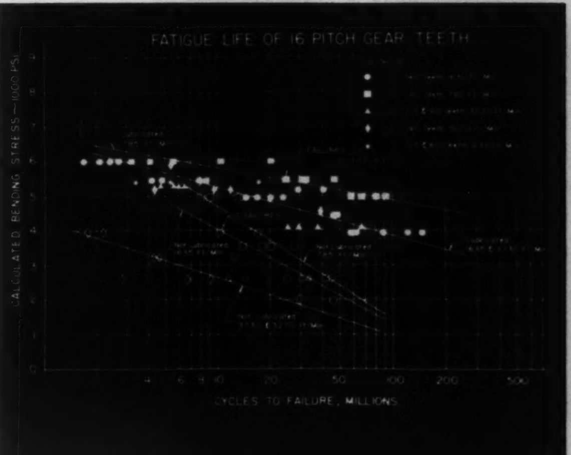


Fig. 4 Results of fatigue tests on gears with cut teeth



molded gears. Nevertheless, the molded teeth showed a definite improvement over the cut teeth in the sizes tested. Although no 16 or 48-pitch molded gears were tested, it was concluded that molded gears of those pitches should have somewhat greater life at any given load than the cut teeth tested. This line of reasoning was followed to establish allowable stress curves in Fig. 9.

The stresses plotted in Fig. 4 were calculated by the Lewis equation for bending stress in a gear tooth:

$$S = \frac{F}{f}\,\frac{P}{y} \qquad (1)$$

where S = bending stress, psi
F = tangential force on tooth, lb
f = face width, in.
Y = form factor, load near pitch point

Equation (1) considers all the load to be carried by one tooth when in contact near the pitch point. A photographic analysis of the teeth under load, both stationary and in motion, showed that this is essentially the condition which exists with the 16-pitch teeth. With smaller teeth, however, some of the load is carried by the adjacent teeth. Nevertheless, the above equation is simple to use, and calculating the stress in this manner results in the points falling along a straight line within the range of random-error deviation.

The form factor Y was calculated from tabulated figures by Buckingham,[4] which were multiplied by 3.1416.

Load-Carrying Capacity of Gears of Zytel

The Lewis equation which was used to calculate the stresses in the gear teeth also can be used to calculate the load-carrying capacity of the teeth by using the test data to establish allowable stresses. However, this equation is generally more useful when rewritten in either of the following forms:

$$T = \frac{SDfYK}{2P} \qquad (2)$$

where T = torque gear can transmit, lb-in.
S = allowable stress, psi, from Fig. 9
D = pitch diameter of pinion, in.
f = face width, in.
Y = form factor for pinion, from factor Y data
K = design factor, from Table 2
P = diametral pitch

or

$$HP = \frac{SDfYNK}{126{,}000\,P} \qquad (3)$$

where HP = horsepower gear can transmit
N = pinion speed, rpm

What are considered to be maximum recommended stresses for molded and lubricated teeth are shown in Fig. 9. To provide a reasonable margin of safety, the lines shown in Fig. 9 have been reduced 25 per cent from the lines which represented failure of the gears on test. Higher allowable stresses are shown for small teeth than for large teeth. This is the result in part of the fact that the load is distributed among more teeth when the teeth are small, even though the method of calculation considers the entire load to be carried by one tooth. Furthermore, the larger teeth tend to run at a higher temperature than the smaller teeth. This has the effect of weakening the larger teeth.

It should be kept in mind that Fig. 9 shows the maximum stresses which should be used when the load is reasonably steady with virtually no shock or impact loading. These should be used with reasonable judgment by the designer, and should be reduced further to compensate for overloading, impact or shock loading, or other such conditions of operation.

The design factor K, shown in Table 2, compensates for those cases where cut teeth may be used instead of molded teeth, for lack of lubrication, and for velocities in excess of 4000 fpm. Other than this, no correction need be made for velocity. Within reasonable limits, it should be possible to approximate allowable stresses for pitches other than those shown in Fig. 9. It would seem unwise, however, to carry this to extremes and use these data to establish allowable stresses for teeth which are much larger than those tested. The combination of large loads and high sliding velocities encountered in large teeth might exceed some limiting value not reached with the teeth tested, beyond which the teeth may fail by surface deterioration rather than by bending fatigue. In such a case, the load-carrying capacity would be limited by resistance to wear rather than by bending-fatigue strength.

It would also seem unwise to apply these stresses to teeth having pitches finer than 48, unless the dimensions of the teeth are very carefully controlled. Small errors could greatly reduce the carrying capacity of such small teeth.

To facilitate the design of gear teeth of Zytel, Equation (2) and the stresses of Fig. 9 have been combined to form design charts which can be used to establish the torque capacity of any given gear, or can be used to establish the size of gear required to transmit a given torque.[5] A design factor K, from Table 2, is used with the charts to increase the torque which must be transmitted, or to decrease the torque which the gear is capable of transmitting.

As when calculating the load capacity of the gears by means of Equations (2) or (3), the results obtained from the design charts should be modified by the judgment of

TABLE 2 VALUES OF DESIGN FACTOR *K* FOR USE WITH LEWIS EQUATION AND DESIGN CHARTS

Teeth	Lubrication	Velocity, fpm	Pitch	Factor *K*
Molded	Yes	Below 4000	16–48	1.00
Molded	Yes	Above 4000	16–48	0.85
Molded	No	Below 1635	16–20	0.70
Molded	No	Above 1635	16–20	0.50
Molded	No	Below 4000	32–48	0.80
Cut	Yes	Below 4000	16–48	0.85
Cut	Yes	Above 4000	16–48	0.72
Cut	No	Below 1635	16–20	0.60
Cut	No	Above 1635	16–20	0.42
Cut	No	Below 4000	32–48	0.70

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[4] Earle Buckingham, "Analytical Mechanics of Gears," McGraw-Hill Book Company, Inc., New York, N. Y., 1949, p. 477.

[5] These charts are available in the pamphlet publication of the paper but are omitted here.

the designer to allow for impact or overloading which may be anticipated.

Other Design Recommendations

The following design recommendations are based on information obtained from various tests and investigations with gears of Zytel:

Size of Teeth. As with metal gears, it is desirable to use the smallest teeth which are strong enough to transmit the necessary power. The limitations of the load-carrying calculations should be considered when determining the size of teeth to be used.

Pressure Angle and Tooth Form. Full-depth teeth with a 20-deg pressure angle appear to be quite satisfactory. The full-depth teeth may be strengthened by making the blank oversize, but this must not be carried to extremes, since the strength gained by making the tooth thicker at its base may be more than offset by the weakening effect of higher temperature caused by the increased normal force and sliding velocity.

The 16-pitch, 27-tooth, 20-deg-pressure-angle gears made with blank diameters $^1/_{16}$ in. oversize had greater life than these same gears made with standard full-depth teeth. Similar gears with 20-deg stub teeth, and with 30-deg stub teeth, had less life than the 20-deg full-depth teeth.

Accuracy of Manufacture. It is desirable to have the teeth as accurately made as is reasonably possible. The life of the gears is shortened when the teeth are not formed and spaced accurately.

Backlash. Backlash must be provided, but performance does not seem to be affected by reasonable variations in backlash. Recommended backlash, measured at room temperature, is given as follows:

Diametral pitch	Backlash, in.
16	0.004–0.006
20	0.003–0.005
32 and finer	0.002–0.004

For high-speed or very heavy load operation, which may heat the teeth, the backlash should be somewhat more liberal than the values listed.

Gear Proportions. Rims, webs, and hubs should be rather generously proportioned to provide ample support for the teeth. This is especially important if the teeth are to be heavily loaded.

In general, the rim thickness beneath the root of the teeth should be at least 3 times the thickness of the teeth at the pitch circle; the web thickness should be about equal to the rim thickness; the hub diameter at least $1^1/_2$ times the shaft diameter; and the hub length at least equal to the shaft diameter.

If the gear is large and the teeth are to be heavily loaded, it is better to mount the gear of Zytel on a metal flange rather than key or spline the gear directly to the shaft.

Molded gears should be designed to reduce or eliminate the formation of residual stresses, and the mold should preferably have a ring gate to maintain concentricity.

Treatment After Molding. The gears should be fully annealed after molding if there is any evidence of residual stresses. It is better to design the gear to prevent the formation of these stresses, rather than to rely on the annealing to remove them, since the annealing process may affect the accuracy of the teeth if the residual stresses are not uniformly distributed. ●

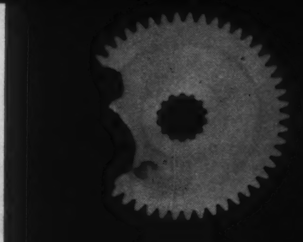


Fig. 5 Fatigue failure by breaking through the rim of 20-pitch molded gear teeth, not annealed

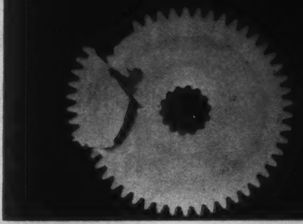


Fig. 6 Fatigue failure of 20-pitch unannealed molded gear teeth by breaking through the rim

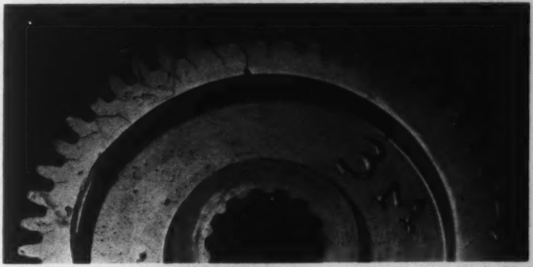


Fig. 7 The formation of cracks at the roots of the teeth preceded the failure of the 20-pitch molded gears

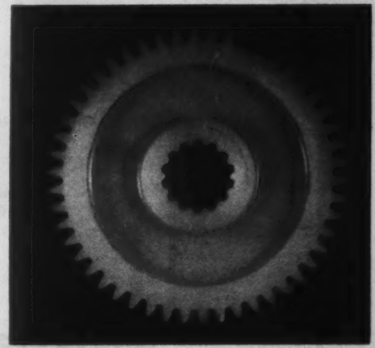
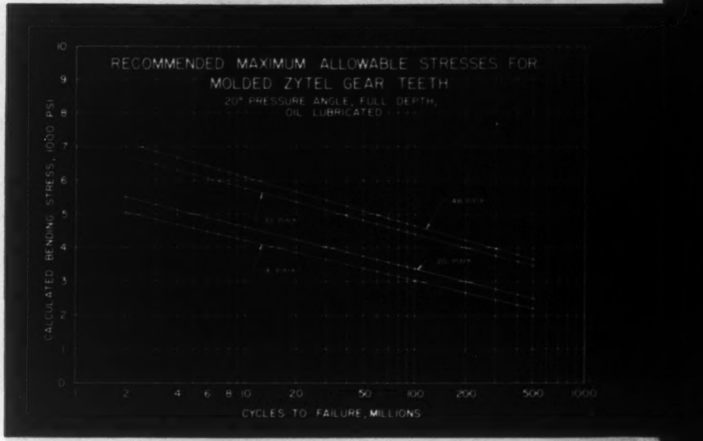


Fig. 8 Fatigue failure of annealed 20-pitch molded gear teeth

Fig. 9



USING STATISTICS to Analyze Materials Handling Problems

Certain basic concepts of statistical analysis are extremely useful when applied to materials handling: how to collect and classify data, how to construct a frequency distribution, and to apply sampling techniques to everyday materials handling

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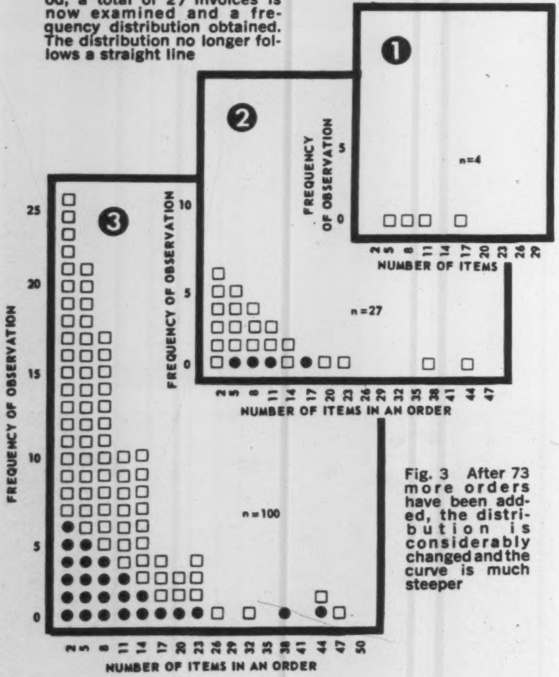

Fig. 1 The number of items shown on four invoices are distributed using a class interval of three; that is, an invoice with 7 items is in the 7-8-9 group

Fig. 2 Using the same method, a total of 27 invoices is now examined and a frequency distribution obtained. The distribution no longer follows a straight line

Fig. 3 After 73 more orders have been added, the distribution is considerably changed and the curve is much steeper

Engineers and managers have learned through bitter experience that the proper statement of a problem is essental to its solution; but many have not learned that statistical techniques can often be of great help in its solution. Several basic statistical tools can be applied to materials handling.

Statistics can be defined as the study of variability. For example, a stock picker may withdraw anywhere from 1 to 50 different items of various sizes in filling a single order. Specifying the equipment to be used for this operation then becomes a problem of "averaging" to get a "typical" order size which fits a large number of the orders received. The variability of number and size is recognized, and an attempt is usually made to arrive at a reasonable solution by "rule of thumb."

In many cases such rough averaging is good enough and has been the basis of judgment for years. Although substantial gains have been made by applying only the experience and judgment of a good materials-handling engineer, there is need for better analytical techniques and a more precise way of analyzing the variables in a problem. The return-on-investment margins are shrinking in the typical materials-handling problem, and materials handling is competing with all of the other aspects of an operation for capital-expenditure money.

Statistical techniques will never replace common sense, judgment, or experience. Indeed, these qualities are essential to the application of statistical techniques. Practically speaking, the basic tools in statistics are the most useful and the most easily mastered.

Data Collection and Classification

Problems are usually recognized as problems because some bit of data seems to contradict a judgment as to what a particular number should be. This requires, of course, that the data be labeled clearly and that the collection be done so that the data are accurate. For example, a common figure used in appraising space utilization is an index of cube space used to cube space available. To compare two such figures, the same rules must be used to derive each index. Similarly, cost per fork-truck move or any other expense incident to unit costs can be compared only if equipment expense is calculated in a uniform manner. Finally, there are pitfalls in accepting data which have been filtered through log sheets, registers, and so forth. It is wise to go to the source of data and to be satisfied that the data mean what they appear to mean. This is an obvious point but is necessary to any statistical analysis.

The corollary to the identification of data is their classification. One of the uses of statistics is to reduce large masses of data to manageable numbers. In classification, prior experience and a knowledge of objective again outweigh statistical technique. Data are classified by attributes, an "either-or" classification, or by variables, where a measurement is taken. For example, "capability of being handled by a 3000-lb truck" would be an attribute of a load, while weight in pounds could be considered as a variable for the same load.

Simple as these notions are, decisions are often made on the basis of haphazard analyses. One firm purchased four 8000-lb-capacity fork trucks because "load reports"

Contributed by the Materials Handling Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of The American Society of Mechanical Engineers. Condensed from Paper No. 58—A-291.

indicated that such capacity would be needed for 30 per cent of the moves. Closer examination showed that the load reports consolidated shipments by invoice number, and that in only 1 out of 50 moves would the large truck be needed, and the number of moves of relatively small loads had been understated. In another case, log sheets indicated that three cranes were "busy" almost continuously. A check revealed that "busy" to the operator meant simply that he was in the cab.

The Frequency Distribution

To reduce data to some manageable form, a device known as a frequency distribution is used. This may be constructed by using check marks on ordinary cross-section paper. The ordinate is the frequency or number of times a given value has been recorded. The abscissa is scaled to represent the values of the measure being analyzed. Thus, if the number of items in an order is the figure in question, the range of values from minimum to maximum expectable would be listed across the abscissa. Then groups of typical orders would be examined and the number of different items on each order would be checked. Suppose that the orders varied from 1 to 50 items. For convenience, these might be considered in groups of three, with 1, 2, and 3 items in the first group, 4, 5, and 6 in the next, and so on. Statisticians would call this a class interval of three. Such grouping results in loss of detail but enables the data to be consolidated.

Assume that the first invoice had 7 items, the next 11, the next 5, and the next 17. Entered into the frequency distribution these would appear as in Fig. 1. Following the first four orders, orders were received with 1, 6, 3, 14, 9, 22, 4, 2, 10, 7, 3, 19, 1, 8, 38, 43, 5, 2, 13, 4, and 11 items. Adding these to the frequency distribution, the result shown in Fig. 2 is obtained. So far, only 27 orders have been considered. Assuming that the orders have been selected without bias (that is typical of all orders), a picture is emerging not only of the average number of items in an order—which could easily be obtained by arithmetic—but of the relative frequencies of values. After 73 more orders have been analyzed, the distribution will appear as in Fig. 3.

Such a presentation is called a frequency histogram. But the general scheme of presenting the relative frequency of occurrence of values is to smooth the histogram into a curve. Such curves, or distributions, are the common means of describing variability. When this visual presentation is combined with certain numerical measures, it is possible to analyze and compare variability in a systematic manner. In addition, certain phenomena result in characteristic frequency distributions. These characteristic distributions have been reduced to equations. Through application of such equations, the analysis is simplified and the utility much enhanced.

The Normal Curve of "Error"

A frequency distribution which follows a normal curve of error forms a familiar "bell-shaped" curve. Special mention is made of this because: (*a*) It is very useful in certain quality-control applications and in the representation of chance-cause-error distributions; (*b*) the misconception that "most distributions are normal" must be avoided, as quite the reverse is true, and while the normal curve represents several of the measures encountered in engineering, it is by no means universal.

Averages of samples, some physical phenomena, and errors due to chance causes alone, generally are distributed normally. A great deal is known about the normal distribution, and it is most useful in sampling and the setting of limits of error. But it is not universal.

Where does the normal curve help in the analysis of materials-handling problems? First, in any application involving automatic weighing. By establishing the variability of errors, predictions can be made concerning the extent of overweight and underweight packages. This also helps appraise the suitability of weighing and filling equipment. Coupled with sampling and the control chart, tolerances in weight can be reduced and worth-while savings effected.

Other Distributions

But what of distributions which are not normal? Returning to the example, the most frequently occurring set of number of items in an order is 1, 2, or 3. The average number of items is approximately 10, and the median (value which half of the orders exceed and half do not) is 8 items. So, designing equipment for the "average" will not fit a third of the orders. At the same time, to design for the maximum of 46 to 48 when the most usual number of items is 1, 2, or 3 seems costly.

Further examination revealed that the five orders with the greatest number of items were new accounts. While these had a large number of different items, there were only a few of each, and the bulk was not great. Use of three standard cartons now enables all but 1$^1/_2$ per cent of the orders to be packed in one carton.

An extension of this type of analysis is used by airlines in calculating weights for baggage, and at least one steamship line has investigated typical cargo crate sizes, to plan stowage in holds. The basic idea is simply to present the pertinent measures in the form of frequency distributions so that management's judgment may operate from facts which are organized.

Sampling

The next basic concept is that of sampling to obtain facts. Everyone forms opinions on the basis of samples, but it is usually recognized that an element of doubt remains in all sampling. This should be no drawback provided two things are remembered: (*a*) In general, the reliability of a sample increases as a function of the number of items in a sample; (*b*) great care must be taken to insure that the whole from which a sample is drawn is well defined and that the sample is drawn properly, without bias.

Since many variables are dealt with in materials handling and volumes of items are usually large, sampling is an appropriate fact-finding technique. Most statistical techniques used in connection with sampling involve determination of the differences between a sample and the whole (population) from which it is drawn.

Work sampling is used to determine personnel and equipment utilization, but the use of sampling should not stop at this point. Sampling can be used to determine average weights, proportion of items with a given characteristic, and in the analysis of any phase of materials handling. It may not be economical to consider all shop orders, all bills of lading, or all move tickets. Nor can all containers be measured economically, or all drums reinspected for broken sealing devices; but all of these can be sampled for information. ●

NUMERICAL

How it works • Where it can be used • The requirements •

"The champion-producing combination of all time, the full-automatic multistation transfer line, is being challenged in its middle years by a relative newcomer, the numerically controlled machine tool," according to one of the authors[1] of this series of papers presented in a symposium on Numerically Controlled Machine Tools, for the Aircraft and Missile Industry, presented at the 1958 Annual Meeting of the ASME.

"The manufacturing organizations most concerned with this aspect of their field," the author continues, "are those having a large number of different parts to make and whose production requirements are such that the same group of machines may be set up several times in one year to run a lot of parts that differ in size, configuration, and tooling from the other lots."

How numerical control works, where it can be applied, the organization and design requirements for its most effective use, the benefits to be gained, and how the system came about are described in the following articles.

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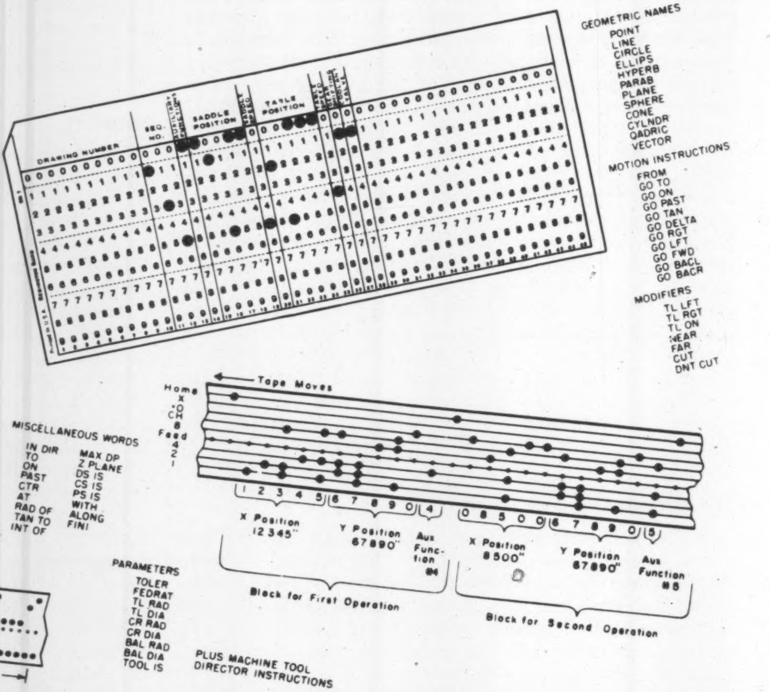
[1] Robert K. Sedgwick.

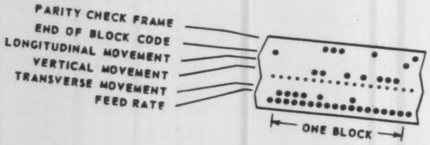
Based on a group of eight papers contributed by the Aviation, Machine Design, Production Engineering, and Instruments and Regulators Divisions and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1958, of The American Society of Mechanical Engineers.

How NUMERICAL CONTROL works...

Numerical instructions punched into cards or paper tape control the sequencing, positioning, and speed of machine-tool operations, and can also be used for such auxiliary control as turning on and off the coolant fluid

In the APT system, part programming begins with simple English-language instructions which are reduced to six-letter or less abbreviations


DRAWING NUMBER
SEQ. NO.
SADDLE POSITION
TABLE POSITION
GEOMETRIC NAMES
POINT
LINE
CIRCLE
ELLIPS
HYPERB
PARAB
PLANE
SPHERE
CONE
CYLNDR
QADRIC
VECTOR
MOTION INSTRUCTIONS
FROM
GO TO
GO ON
GO PAST
GO TAN
GO DELTA
GO RGT
GO LFT
GO FWD
GO BACL
GO BACR
MODIFIERS
TL LFT
TL RGT
TL ON
NEAR
FAR
CUT
DNT CUT
MISCELLANEOUS WORDS
IN DIR
TO
ON
PAST
CTR
AT
RAD OF
TAN TO
INT OF
MAX DP
Z PLANE
DS IS
CS IS
PS IS
WITH
ALONG
FINI
Tape Moves
Home
X
·O
CH
8
Feed
4
2
1
1 2 3 4 5
6 7 8 9 0
4
0 8 5 0 0
6 7 8 9 0
5
X Position 12345"
Y Position 67890"
Aux Function #4
X Position 8500"
Y Position 67890"
Aux Function #5
Block for First Operation
Block for Second Operation
PARAMETERS
TOLER
FEDRAT
TL RAD
TL DIA
CR RAD
CR DIA
BAL RAD
BAL DIA
TOOL IS
PLUS MACHINE TOOL DIRECTOR INSTRUCTIONS


PARITY CHECK FRAME
END OF BLOCK CODE
LONGITUDINAL MOVEMENT
VERTICAL MOVEMENT
TRANSVERSE MOVEMENT
FEED RATE
ONE BLOCK

CONTROL

Servo systems, tape readers, and modern mechanical components combine to make the machine tool a complete manufacturing center that can operate with a minimum of attention

The benefits to be gained • History

Automatic Programming Methods

by Joe Crabtree[2]

Automation has been applied to many different machine-tool applications. The majority of these have been limited to applying sequencing controls to transfer-type machines, or positioning control where a machine's table is moved to various positions referenced from a specific point. Positioning control can be used for drilling, tapping, boring, riveting, punching, grinding, and similar operations, as well as tool selection and the control of auxiliary machine functions.

Programming for automatic positioning-controlled systems consists of preparing an operation-sequence sheet defining numerically the position changes, the tools to be used, and machine functions to be controlled. No computer is required to prepare such programs. An individual familiar with the machine's operations can learn to program it in a few minutes. Much of this programming consists of working out a logical motion from point to point, so that the least amount of movement of the basic material is required.

In the numerical positioning-control system, numerical data define individual points to which the machine is

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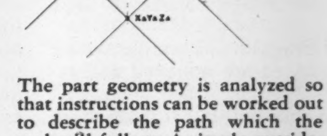
[2] Director of Applications, Remington Rand UNIVAC, New York, N. Y.

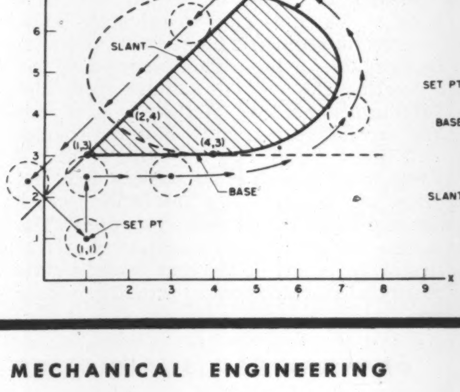
Condensed from ASME Paper No. 58—A-268, "Automatic Programming Methods for Numerical Control."

A simple part described in this abbreviated-language and numbers system looks like this, and these pre-processing instructions will be translated by the computer into actual program instructions

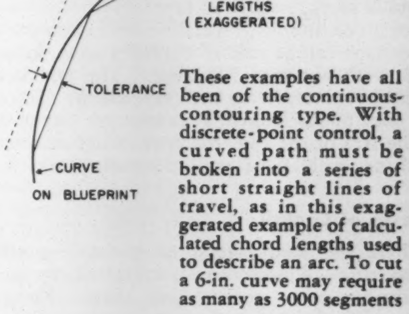
At present the APT system is two-dimensional and contains full preprocessing facilities only for points, lines, and circles. Quadratic curves in two dimensions — such as ellipses, hyperbolas, or parabolas; and the basic quadric surfaces in three dimensions — such as planes, spheres, cones, cylinders, ellipsoids, hyperboloids, and paraboloids — can be programmed if the less convenient language of the control-element program itself is used



The part geometry is analyzed so that instructions can be worked out to describe the path which the tool will follow. A simple outside-corner junction looks like this



```
          TL DIA/+1.0
          TOLER/+.005
          FED RAT/80
          HEAD 1, MODE 2, ON SPIN, ON KUL
SET PT =  FROM, POINT/1,1,3
          IN DIR, VECTOR/0,1,0
  BASE =  GO TO, LINE/1,3,3,4,3,3
          WITH, TL RGT, GO RGT, ALONG/BASE
          GO FWD, ALONG, ELLIPS/4,5,3, $$
          +.33333,0,0,0,5,0
 SLANT =  LINE/1,3,3,2,4,3
          GO LEFT, ALONG/SLANT, PAST, BASE
          GO TO/SET PT
          OF KUL, OF SPIN, END, FINI
```



CALCULATED CUTTER CENTER PATH
CALCULATED CHORD LENGTHS (EXAGGERATED)
TOLERANCE
CURVE ON BLUEPRINT

These examples have all been of the continuous-contouring type. With discrete-point control, a curved path must be broken into a series of short straight lines of travel, as in this exaggerated example of calculated chord lengths used to describe an arc. To cut a 6-in. curve may require as many as 3000 segments

to be positioned. The control system performs no interpolation or path computing between these points.

Numerical Position Control

In using numerical position control, the engineer starts with a blueprint and transfers the dimensions of the part to a work sheet. For each machine motion or position to be controlled, he must specify a separate numerical dimension or position.

Given the work sheet, a clerk records the program by keypunching the numerical data onto standard tabulating cards or by typing to produce punched tape.

Punched cards or paper tape provide the storage for the machine-control program. This program can be withdrawn from file and used at will to produce a desired part.

In use, the operator loads the workpiece into the machine, locates the cutter at the setup point, places the punched cards or paper tape into the reader, and pushes the "start" button. This puts the machine into automatic operation until the machining is completed.

Punched-Tape Versus Punched-Card Control

Punched tape and punched cards are both used for control. What are the factors that govern their use in an individual case?

The card-reading speed for numerical position control is several times faster than for tape. Tape is read at 6 digits per sec, whereas an entire card can be read in less than 1 sec. If a machining operation is to drill a hole which takes 10 sec to complete, then the control has 10 sec to read new information. Generally, this is ample time for reading and the speed of reading then becomes unimportant. However, if the operation were punching, shearing, or welding, the machine cycle would be relatively short. This means that new information must be fed to the control in a short time, else the machine must wait for its next instruction. In this case punched cards offer an advantage because of their faster reading time.

Making a change in a card program is a simple matter—the card or cards to be changed are removed and replaced with new ones.

A tape program also can be changed, but it takes more effort. Since a tape program is contained on one continuous length of tape, the section to be changed must be cut out and a new section spliced in.

Cost of the reader is another consideration. Card readers are larger, more complicated devices, and cost about five times more than tape readers. Both tapes and cards are easy to store but cards require three times as much storage space as tape.

For a continuous, repetitive operation the ends of the paper tape can be spliced together to make a continuous loop with automatic feeding. The punched-card deck must be replaced with each repetition. Since the tape is one continuous length, it cannot get out of sequence.

The size of the run, the probability of change, and the machine cycle time will determine which is best.

Classes of Control

There are two classes of control—positioning and contouring. Positioning is more widely used and more applicable to a general job shop. No computer is required to prepare these programs. Dimensions are taken directly from the blueprint.

Contouring or variable-path control is used to mill complex, short-run parts in two and three dimensions. The path of the cutter is guided continuously by numerical control eliminating the necessity for producing templates.

Machines performing continuous cutting operations, such as contour milling or contour turning, require a substantial amount of calculation to locate the instantaneous position of the cutting tool at all times. The machine tool must be directed exactly where to move and may not be physically able to accept data that will cause cutting movements of more than 1 in. at a time. For example: To locate a 6-in. line on a part requires the specifications of the two end points; however, to cut this line through a piece of metal, 6 intermediate points on the line might be required. As more complex curves are desired, the job of directing the movements of the cutting tool becomes more difficult, since a curve must be approximated by small straight-line segments—to cut a 6-in. curve may require 300 segments. The degree of approximation determined the accuracy of the final cut; therefore, the accuracy of the part to be produced must be taken into consideration, adding to the volume of necessary calculations.

Cutter-Center Offset

Another factor in the program is the cutter-center offset. The program does not define the outline of the part, but rather the path the cutting tool must take. The machine tool locates the position of a cutting tool by the tool's center. The problem of offset can be illustrated by a snowplow operation; you remove snow from the road not by directing the center of the plow down the edge of the road, but rather by employing the center-offset principle in that you direct the plow's center travel in a path so that the edge of the plow's blade travels along the edge of the road. This is the same problem in programming a contour. The problems of offset, accuracy determination, and voluminous point-location calculations make the use of a computer a necessity for contouring control. The computer is not used as part of the machine-control system, but its output (punched cards, magnetic tape, or punched paper tape) is used to control the machine tool.

Program Preparation

Almost any standard business computer can handle program preparation for two-dimensional parts; that is, parts where the outline is described by plane curves. Generally, the program calculation is accomplished on a computer by making use of a library of subroutines. This library consists of many individual computer subroutines, each of which is able to calculate point locations for one certain geometric figure (such as circle, parabola, or straight line). Input data prepared by the part designer describe the part in tabular form and specify the subroutines needed. Actually, it is not necessary for the part designer to know how to program a computer. He must merely lay out the points of departure, the beginning of each of the various arcs, and the radius of those arcs in a form that can be interpreted by the computer to produce the necessary program. The computer uses this information to calculate the large volume of intermediate points on the part needed by the numerically controlled machine tool to actually produce the desired part.

Automatically Programmed Tool System

by Douglas T. Ross[3]

A NEW APPROACH to automatic-programming systems is being developed which is subtly but fundamentally different from the older approach of the library of subroutines controlled by executive routines. The name APT System (Automatically Programmed Tool System) was coined for this approach which takes account of the disparate characteristics of the human part programmer, the general-purpose digital computer, the machine-tool director, and the over-all problem of numerical-control programming. Rather than treating each separate problem which arises in the preparation of numerical data by a separate subroutine, the APT System contains a general skeleton program which represents a "systematized solution" for moving a cutting tool in space. This skeleton program is then fleshed out for any particular application by adding to it so-called normal-vector and directed-distance subroutines for each surface involved, to create a specialized computing program for the problem at hand. Since the skeleton portion of the program obtains a solution for the hard part of the problem and does not depend upon the particular surfaces involved, the system may be expanded arbitrarily merely by adding normal-vector and directed-distance subroutines for each new surface type.

An APT System is organized in a way which is very similar to the organization of modern general-purpose digital computers. It may be considered to be the simulation of a specially designed computer, whose features are especially suited to the part-programming process, by the programming of a general-purpose computer such as the IBM 704.

Input Translation

In operation, the input phase is broken into two parts. The "input translation program" merely recognizes the English words and numbers which have been punched onto the cards and converts these into coded logical-equivalent computer words which it assembles in sequence in appropriate tables. The actual translation of the language meaning from human terms into computer terms is performed by the preprocessing programs. The "instruction preprocessor" handles all instruction statements, and performs primarily logical-language translation. The "definition preprocessor" performs mathematical transformations, and converts geometric definition statements from any one of many forms which the human part programmer can use, into the single fixed canonical form for each surface type, as required by the computer programs. For example, it is possible for the part programmer to specify a circle as passing through three points, as being tangent to two lines with a specified radius, or in a number of other forms. This can be done even though the computer programs require that a circle be specified by the canonical form which consists of the co-ordinates of the center and the magnitude of the radius. At the end of the translation phase the instruction preprocessor leaves an equivalent version of the original part program in computer terminology in one storage block, and in another storage block the definition preprocessor leaves a listing of all canonical forms for geometric quantities which have been defined.

The Calculation Phase

The calculation phase of the operation of the APT System involves three main programs. The "arithmetic-element program" calculates successive cutting-tool locations based upon the surfaces and curves defined and the tolerance of approximation which has been specified. It then records these tool-center locations in sequence on a magnetic tape. The arithmetic-element program is the embodiment of the "systematized solution" to the problem of moving a cutting tool along a space curve. This skeleton program is fleshed out by drawing upon the appropriate normal-vector and directed-distance subroutines which are contained in the library of surface solutions. The "control-element program" interprets the translated program prepared by the instruction preprocessor and sets up the appropriate interconnections between the arithmetic-element program and the library of surface solutions so that the tool follows the path specified by the part programmer in the original English-like APT-language program.

When the calculation phase is completed, the post-processing phase takes over. Each machine tool has different dynamic characteristics, and each type of machine-tool-director system has a different numerically coded director language. It is the function of the post-processing and output routines to transform the tool-center location data supplied by the arithmetic-element program into the form required by the particular machine-tool director which is being used. The post-processing program automatically corrects the feed-rate information requested by the part programmer so that the machine tool will not overshoot excessively on sharp corners. Some directors also require that intermediate points be calculated in addition to those supplied by the arithmetic-element program. Instructions in the original APT part program which control various functions of the machine tool, such as turning on and off of coolant flow, are also inserted into the final output tape by the postprocessor. The final operation of the system is to punch out cards containing the numerical part program in the director's language for conversion on off-line equipment to magnetic or paper tape as required by existing directors.

An APT System suitable for industrial use has been under development by a large group of aircraft companies under the co-ordination of M.I.T. The initial system is known as the 2D-APT-II Phase I System, and represents the first plateau or level of achievement which is considered a complete APT System. The 2D indicates that the part-programming language is designed primarily for producing two-dimensional parts, and the abbreviation APT II indicates that the system is programmed in terms of three-dimensional space curves. (The next level of sophistication of APT Systems, called an APT III System, is programmed in terms of entire regions of surfaces in three dimensions, and is still in the research stage.)

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[3] Head, Computer Applications Group, Servomechanisms Laboratory, M.I.T., Cambridge, Mass.

Condensed from ASME Paper No. 58—A-236, "A Progress Report on the 2D-APT-II Joint Effort for Automatic Programming of Numerically Controlled Tools."

Features of the Phase I System

In order to minimize the initial computer-programming task, the 2D-APT-II Phase I System contains a minimum of features for the part programmer, but still represents a complete and usable automatic-programming system within its limited capabilities. The present system contains many features which do not appear in the other automatic part-programming systems, but it also lacks features which others possess. It is planned that these basic features will be expanded in the future so that the APT System will grow in usefulness and convenience. Although the arithmetic-element program has full three-dimensional capabilities, the input language is primarily two-dimensional and at present contains full preprocessing facilities only for points, lines, and circles. The vocabulary does permit, however, the specification of quadratic curves in two dimensions such as ellipses, hyperbolas, or parabolas, and the basic quadric surfaces in three dimensions such as planes, spheres, cones, cylinders, ellipsoids, hyperboloids, and paraboloids. Full three-dimensional part programming is possible if one wishes to use the less convenient language of the control-element program itself.

In order to minimize computer programming, all words in the APT vocabulary must contain six or fewer letters or symbols, ignoring spaces. Therefore, although a plane is called for by the word PLANE, the abbreviation HYPERB is used for a hyperbola. Arbitrary six-character symbols may be defined by the part programmer to give names to individual geometric quantities for reference in APT statements. For example, the statement

PLATE 1 = LINE/PNT A, PNT 3B

states that the symbol PLATE 1 is the name which will be used in succeeding instructions for the line through A and point 3B, where these points have similarly been given the names PNT A and PNT 3B in previous statements. An example of an instruction statement using the symbolic name PLATE 1 might be

GO RGT, WITH, TL LFT, ALONG/PLATE 1

which obviously says "go right with the tool on the left side along the curve named PLATE 1," and would result in a motion from the current tool location along the line through point A and point 3B with the tool offset to the left with respect to the direction of motion along the line. The motion along this line would be terminated by the next instruction which might be

GO LFT, ALONG/CIR 3

which states that when the tool has reached the intersection of PLATE 1 and the curve whose name is CIR 3 (say a circle), the tool is to switch to motion along the circle, still with the tool on the left. In this step-by-step manner, the part programmer instructs the APT System how the tool is to proceed in order to produce the desired part.

The excessive use of commas in the APT statements is an artifice for the convenience of the computer program, but does not hinder the part programmer. In the present system, some of the words such as WITH and ALONG are optional, and may be included to make more readable manuscript or may be omitted by the experienced part programmer who desires a condensed manuscript. All of the other statements in the language have a similar English-like format and the words and definitions are easy to learn and apply correctly. For example, the APT statement

ON KUL, ON SPN, GO RGT, TL LEFT, CIRCLE/
CNTR AT, +2., +3., RADIUS, +5.

is an example of a lengthy but condensed statement which says "turn on the coolant, turn on the spindle, go right with the tool on the left side along the circle whose center is located at $x = +2, y = +3$, with a radius of +5." The use of plus signs and decimal points is optional. Points, lines, and circles may be defined in many ways in terms of previously defined quantities using words such as TAN TO for "tangent to" and INT OF for "intersection of." It is possible to become quite versatile in using these preprocessing features since the virtuosity of the part programmer is limited only by his knowledge of constructions with ruler and compass. For certain parts these preprocessing features can result in extreme savings of time and manpower, with increased reliability as well. The extension of the facilities to wider classes of geometric curves and surfaces including airfoil shapes will result in very substantial economic savings in using the APT System.

It is also possible for the part programmer who has some knowledge of the internal workings of the APT System computer program to program in full three dimensions along any curve which can be defined as the intersection of any two surfaces for which the system contains normal-vector and directed-distance programs. In the Phase I System, no effort has been made to supply a convenient English-like language for full three-dimensional operation, but these features are planned for the near future.

In addition to this, the present system also does not have provision for transformation of co-ordinates or automatic cleanout of pockets. Similarly, although the system will allow a very wide variety of cutter shapes to be used, including flat end-mills, ball end-mills, filleted end-mills, conical cutters, and a wide variety of more unusual shapes related to these standard profiles, the system does not yet have provision for automatically compensating the effective cutter radius if the entire surface of the cutting tool is not in contact with the workpiece. For instance, in the case of a shallow pocket with sloping bottom which is to be cut by a filleted end-mill whose corner radius is much greater than the pocket depth, the effective tool radius varies continuously because some of the corner-radius curve is above the depth of the pocket side.

Correction of these shortcomings and the addition of many new surface types and preprocessing forms are the province of Phase II. Several routines for including arbitrary surfaces defined by a mesh of points, or approximated by a series of conic sections or polynomials such as are now used in pattern making from templates, are already tested or else nearing completion. It therefore seems likely that a number of Phase II improvements will be ready for almost immediate incorporation in the Phase I System.

Organization of a Numerical-Control Operation by James J. Childs[4]

THE establishment of a numerical-control operation normally involves five major groups or functions: (*a*) Plant equipment (equipment engineering); (*b*) tool planning (methods engineering); (*c*) tool design (part programming); (*d*) computing; (*e*) maintenance.

The plant-equipment department must determine what equipment should be procured. The tool-planning department decides how the part should be machined and then passes this information on to the tool-design department. The part programmer, or tool designer, must then determine the sequence of cuts and describe the outline of the part. The computing department accepts the part programmer's information and performs the bulk of the calculations, utilizing small, medium, or large general-purpose computers. The computing department is responsible for producing the finished tape.

This flow offers an extremely cursory description of the step-by-step procedure in preparing the required conveying medium. In order more fully to appreciate the departmental functions, a more detailed analysis is in order.

Plant Equipment—Equipment Engineering

The primary responsibility of this group is first to determine whether numerical control is economically feasible and practical for the company's operation. Numerical-control equipment is rather expensive and savings must be weighed carefully against expenditures. If it is determined that numerical control will prove an advantage, the particular system or systems must then be selected.

Tool Planning—Methods Engineering

The function of this group is to:

1 Select the most suitable parts for numerical-control machining. Savings in tooling and production costs are the primary considerations.

2 Describe the sequence of cuts, speeds, feeds, cutters, and all holding fixtures required. The standard-operation sheet is also prepared by this group.

3 Prepare and initiate all necessary tool orders, cutter requisitions, and similar forms.

A thorough understanding of the operation of the machine, its limitations, and its advantages is required by the methods engineer. Since this is a relatively new field, formal training at the manufacturer's facilities is strongly recommended.

Tool Design (Part Programmer) and Computing

Because of general background, education, and experience, the tool designer is felt to be the most suitable person for calculating the information required for preparing the conveying medium. The men chosen at the author's company generally had several years of cam-design experience. These somewhat rigid qualifications are expected to be lowered as the program and computer techniques progress.

The part programmer unquestionably shares the greatest burden of the entire process. He must:

1 Outline a path describing the detailed sequence of cuts on the part from either engineering prints or from a print which is especially designed for numerical control. Unless parts are designed with numerical-control machining in mind, the conventional engineering drawing is normally not suitable. The part programmer must then prepare a separate print.

2 Calculate the co-ordinates of all intersection points.

3 List co-ordinates, with other instructions, on the manuscript.

The programming system developed at Republic is capable of handling all curves in a two-dimensional plane with computer assistance, or any three-dimensional part without computer aid. Computers such as the IBM 704 are more suitable for computations on complex parts.

Maintenance

It would be somewhat presumptuous if we were to expect the automatic factory of the future to operate with far less manpower than is now required and not raise the technical skill and number of maintenance personnel. Numerical-control equipment is substantially more complicated than equipment with which the majority of maintenance men are familar. This is particularly true of the electronic and electrical components. It is for this reason that most machine-tool builders or systems manufacturers offer special training courses.

The use of special test equipment is strongly recommended. A relatively small investment in this category will save valuable machining hours by reducing trouble-shooting time considerably.

Since a satisfactory result can only be achieved through close co-operation of numerous talents, a positive, co-ordinated, and somewhat novel program should be established. Most aircraft companies have established formal programs or committees consisting of representatives from tool planning, tool design, computing, equipment engineering, plant engineering, maintenance, and shop supervision.

For the present, numerical control appears to be an extremely economical and practical solution for producing different parts, in relatively small lots, with general-purpose equipment. Since the F-105 airplane has been in production with conventional milling machines for some time prior to numerical-control machining, a positive economic comparison could be made. Tooling costs for one intricate part were reduced 54 per cent and machine time by 56 per cent. In two other instances, machining time was reduced by 73 per cent and 75 per cent, respectively. Quality, tool-storage requirements, and scrap reduction have been improved considerably over the past year with the utilization of numerically controlled milling machines.

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[4] Chairman, Numerical Control Program, Republic Aviation Corporation, Farmingdale, N. Y.

Condensed from ASME Paper No. 58—A-238, "Operating Experience With Numerical Control."

Designing for Numerical Control by Robert K. Sedgwick[5]

Numerically controlled machine tools have most of the characteristics of the more familiar type of machine, and at first glance there is little to distinguish the two except the preponderance of control cabinets adjacent to the former. The actual mechanical design of the two types is also very little different until close inspection is made of some of the details. Two factors are important. One is that the machine as a whole becomes part of a servo system as soon as numerical control is added to it. The other is that the designer has seized the opportunity presented for a wholesale redesign to incorporate all the latest features he can think of, including an unusually wide range of feeds and speeds, in order to achieve the maximum degree of flexibility and universality of application.

The Design of the Machine

The design of the machine from the servo standpoint requires that the typical disturbing elements, friction, backlash, and deflection be brought within quite narrow limits. It is sometimes said that these three must be reduced to the lowest possible level, but this is not necessary. In fact, it is quite easy to reduce friction too much. Backlash in certain places does no harm unless it is far beyond reasonable limits, and deflection alone remains persona non grata. Fortunately, machine designers have been working on reduction of deflection continuously for other reasons, and no new techniques are required.

The realm of backlash has been invaded by such things as recirculating ball screws, which can be heavily preloaded, gears mounted on adjustable center distances, careful provision for bearing take-up, and extremely close tolerances on runout.

Not the least part of the design problem is that concerned with incorporating into the machine the necessary degree of flexibility to enable it to cover a wide variety of applications. It is essential, of course, that any machine whose purpose is production of small lots, rapidly changed, must have the widest range of capacity that can be provided. It is quite common for parts in one family to range from steel to magnesium, and the necessary tools from a 6-32 tap to a 3-in. shell-end mill. Speeds, then, should be available in the range from perhaps 75 rpm to up in the thousands. Spindle speeds of 3600 rpm were formerly thought high enough. Now, 7200 is common and 14,400 is occasionally seen. These speeds refer to full-size machine tools. They no longer are limited to hand-held grinders, which now top 50,000 rpm in some cases. Obviously, few machines, numerically controlled or otherwise, are capable of the extreme range indicated by these figures, but ranges of 100 to one are often seen, and the buyer is constantly agitating for wider ranges. In addition to range, it is desirable to have as many different speeds as possible, and there is now a demand shaping up for infinitely variable spindle speeds in numerically controlled machines. This is possible, but really not necessary, and the best compromise seems to be

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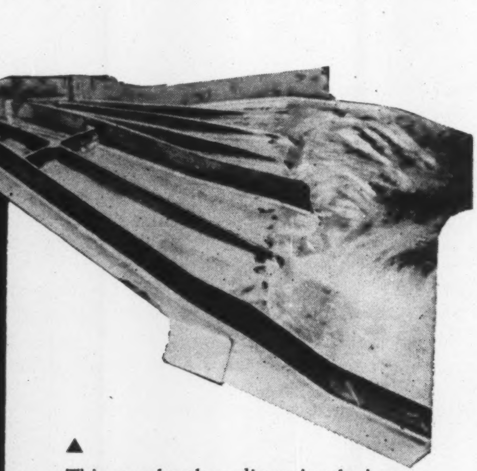
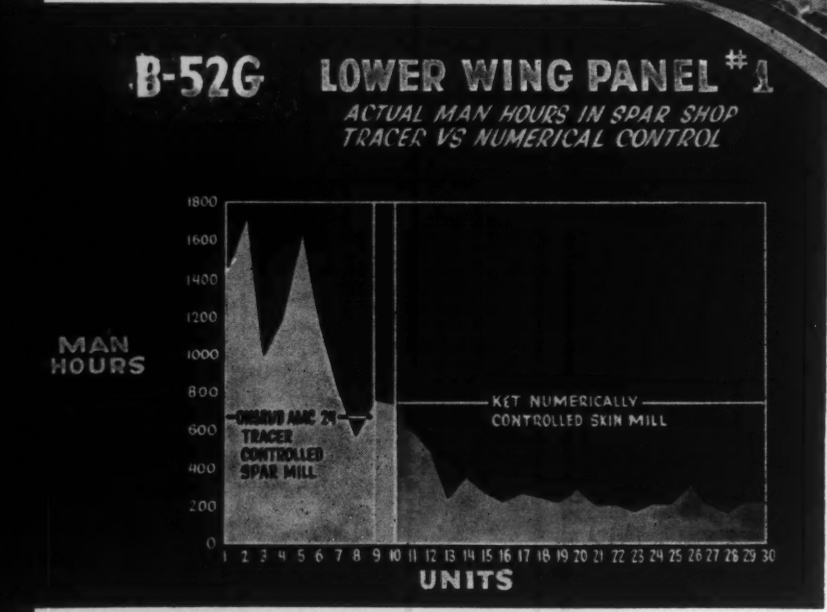
Condensed from ASME Paper No. 58—A-288, "Automation Approach Using Numerical Control."

What it can do...



▲ This complex three-dimensional wing-spar cap for Republic Aviation's F-105 Fighter Bomber is now being produced in quantity lots on a numerically controlled Kearney & Trecker profile-milling machine



◀ Boeing Airplane Company's Wichita Division has achieved spectacular savings in man-hours in producing lower wing panels with the use of continuous-path numerical control a selection of at least 32 different speeds. Geometric progression and arithmetic progression both have their advocates, although until recently it was thought the geometric was the only reasonable system.

Automatic Tool Change

It is possible, with numerical control, to have a large magazine full of tools and automatic tool change. At least three different machine-tool builders now offer this feature. Any kind of tool that is operated by a rotating spindle can be so treated if it is not too large. This includes drills, taps, reamers, counterbores, center drills, end mills, face mills, and even backfacing tools, in some cases. The variety is constantly increasing. Some types, like the backfacing tool, require special control circuits.

Hundreds of different tools can be coded in various ways so that the machine finds the proper tool under instructions from the tape reader. At any time, the operator can remove some tools and insert others without stopping or otherwise disturbing the machine.

Design of Product for Numerical Control

To take full advantage of the potential saving through the use of numerically controlled machines, it is often necessary to redesign the product to some degree. For instance, many parts are now so designed that, after going through the machine line once, they have to be sent through again, mounted in a different position, or in a different fixture, to expose surfaces previously hidden. In a goodly number of cases, this second run achieves only a minor amount of additional machining, such as drilling and tapping of oil-drain holes, milling a boss for an inspection cover, and so on. If the part is in a family, it may take just as long to go through the second time as the first, but the actual cutting time in each station will be small so that capacity is wasted. Clever redesign can often provide for the necessary features to be machined in the original setting, thus saving the extra run entirely.

Another way that redesign saves is in the reduction of the total number of tools. Although tool changes can be made very fast, they still reduce cutting time, and every extra tool in the set involves the tool-maintenance people in extra work and expense. Also, the sheer bewildering variety of tools now in use on many parts is a severe handicap to the programmer, who has to keep the whole picture in mind. One fairly complex milling-machine part analyzed last fall required 87 different tools for its completion. A tentative redesign, not yet adopted, brings this number to somewhere down in the twenties.

Conscientious designers have always done these things wherever practical, but these ideas can be carried along much further when numerical control is used, before the point of diminishing returns is reached. It pays to add otherwise useless material to simplify the machining. It pays to use fasteners and bearings slightly too large to save needless tool changing. It pays to throw in a design change whenever savings are indicated.

It should be obvious that the product designer should not be isolated from the methods and production people. If possible, the decision to machine a part on a certain machine should be made before the part is designed. This, of course, gives the designer the best possible guide and enables him to extract as much from the numerical-control principle as can be expected.

Retrofit Applications

by Peter D. Tilton[6]

THERE is little doubt that numerical controls can be successfully retrofitted to existing machines. Most numerical-control-system developments originally employed modified conventional machine tools, and these systems were eminently successful in demonstrating the advantages of numerical-control methods [1–6].[7]

Retrofit poses no insurmountable technical problems. Some combinations of machine-tool and control system will prove to be relatively straightforward. Others, though technically possible, may be much more troublesome. The effort, and hence the cost, of retrofit will depend also on the type of system selected, and some combinations will not always be economically justifiable.

Technical Requirements for Retrofit

Most of the technical problems which must be overcome in retrofit are concerned with applying power actuators since each machine function to be numerically controlled, such as table feed, slide motions, and auxiliaries (spindle motor, coolant, and similar functions) must be operated by some sort of automatic power device. Simple on-off functions may be readily controlled by relays or valves, but each axis of machine motion (such as table, carriage, or cross slide) requires servomechanism control to produce accurately co-ordinated movements.

Not only is it necessary to design the installation of additional servo components, such as servomotors, feedback instruments, and their mechanical connecting links, but also the dynamic response of the entire system must be analyzed and tested to insure satisfactory performance.

High-gain servos with broad frequency-response bandwidths have good dynamic stiffness and fast action and will enable the machine to maintain close accuracy while following straight or curved paths at high feed rates or under heavy cuts [7]. Poor servos will compromise machine-tool performance in terms of speed, accuracy, or surface finish because of their sluggishness or through a pronounced tendency to oscillate if the effects of deflection, backlash, windup, friction, and stiction are excessive [8].

Servomechanism design procedures are fairly straightforward once values are determined for all important parameters. Considerable effort may be required to measure such factors as the cutting forces or the stiffness, mass, and friction of the machine tool. Variations from one type of machine to another and for individual machines make it extremely difficult to obtain a universally applicable retrofit system.

Retrofit specifications usually provide for certain modifications of the machine structure, ways, and power drives which will improve the potential performance.

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[7] Numbers in brackets designate References at end of paper.

Condensed from ASME Paper No. 58—A-290. "Retrofit Applications of Numerical Control to Existing Machines."

The design, testing, and debugging necessary to develop an optimum high-performance servo system for an old tool can become so involved and costly that beyond a certain point it becomes uneconomic to continue to strive for the utmost retrofit performance.

Although great improvements are possible, numerical control cannot correct for many types of intrinsic machine defects, such as misalignment, excessive wear, or lack of rigidity. Retrofit, therefore, will not be a panacea for all difficulties inherent in a poor machine.

Characteristics of Available Systems

Regardless of whether the original equipment manufacturer, another machine-tool manufacturer or rebuilder, the user, or the system developer does the retrofit, the task requires integrated engineering and development effort which embraces: (*a*) A control-system concept, including provision for data-processing and control features to suit the application as well as the design of machine-control circuits and equipment; (*b*) a servomechanism system, designed and tested to meet the machining requirements; and (*c*) detail design for fabrication and installation of all parts necessary to modify and adapt the machine tool.

These requirements can be met by custom-engineered installations although development costs may be unusually high. Alternatively, only a limited number of proved retrofit combinations exists. These are primarily developmental prototypes, not all of which have resulted in commercially available systems. Very few systems have been conceived and developed specifically for retrofit, but more may become available.

The most important characteristics to consider in assessing a system for retrofit are its applicability to various kinds of tools; its principal technical features, such as the type of servomechanisms; system logical design; data processing; performance capabilities; and costs.

Comparison of New-Tool and Retrofit Capabilities

New-tool and retrofit system applications will differ mainly in the performance of the basic machine tool rather than the electronic control unit and the data-processing system. Thus, retrofit will provide the fundamental accuracy of the control data, the co-ordination of simultaneous motions for reduced setups and complex work, and all other important capabilities pertaining to the numerical-control method. This is important, because these benefits are very great indeed and will usually exceed by far any probable differences in the equipment performance of comparable new and retrofitted systems. Accuracy and surface finish are the principal quality factors to consider.

The productive capacity of a machine depends on many factors other than equipment performance, and such things are largely independent of equipment performance and the new tool or retrofit question. Scrap rate, maintenance down time, and what may best be described as the effective metal-cutting capacity of the machine are significantly different for new and retrofit applications.

Most of these factors are interrelated, since accuracy, surface finish, and scrap rate usually can be improved—at least to a certain extent—by reducing feed rate and working at less than the maximum metal-removal capacity of the tool.

It is probable that a new machine for numerical control may have a basic capacity on the order of 25 to 50 per cent greater than that of a comparable 10-year-old machine for retrofit, with the higher values applying to machines designed for optimum dynamic performance. However, it will be difficult even under numerical control to exploit this differential fully, since the geometry of most parts seldom permits machine operation at full spindle power.

Although the accuracy, surface finish, and part spoilage will be somewhat poorer with retrofitted machines,

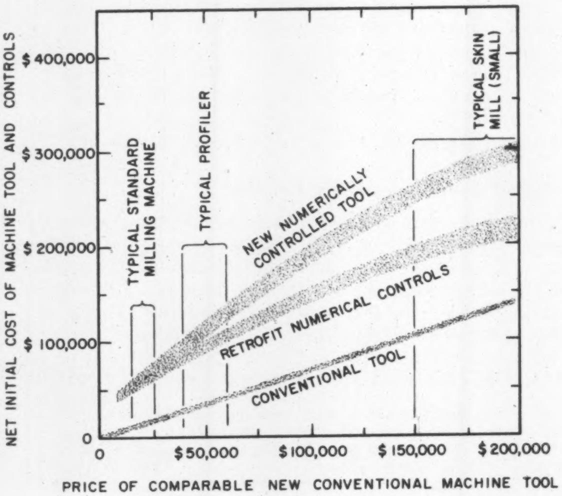
New or Retrofit ?

The economic advantage of retrofit over new numerically controlled tools increases as the price range goes up ▼

▼ The operating cost of retrofit tools appears to be higher, largely because control-equipment costs are amortized over the shorter remaining life for the used and rebuilt tools

EXAMPLE OF CONVENTIONAL AND NUMERICALLY CONTROLLED MACHINE OPERATING COSTS
(Based on $20,000 Machine Tool and $50,000 Added Numerical Controls, at 3500 Hours Annual Utilization)

Cost Element	New Tool with Conventional Control	Numerical Control	
		Retrofit	New Tool
Machine			
Fiscal charges	$ 0.60	$ 0.88	$ 0.81
Maintenance and repair	0.17	0.30	0.23
Floor space, 200 sq ft	1.70	1.70	1.70
Power	0.03	0.17	0.17
Subtotal	$ 2.50	$ 3.05	$ 2.91
Controls			
Fiscal charges		$ 2.39	$ 1.51
Maintenance and repair		0.57	0.57
Floor space, 25 sq ft		0.21	0.21
Power		0.10	0.10
Subtotal		$ 3.27	$ 2.39
Labor			
Direct wages (operator)	$ 2.50	$ 2.50	$ 2.50
Fringe costs (vac., etc.)	0.75	0.75	0.75
Indirect labor costs (supv'n, etc.)	2.75	2.75	2.75
Subtotal	$ 6.00	$ 6.00	$ 6.00
TOTAL OPERATING COST RATE, per hour	$ 8.50	$12.32	$11.30



the most significant difference between new-tool and retrofit system performance will lie in the maximum feed rate allowable for comparable machine results.

Cost Factors

Two kinds of costs are important to potential numerical control users—net initial outlay, and machine operating cost. Costs associated with data processing, tooling, and production planning are not applicable since they pertain more to the choice of system and method of application rather than to new or retrofit equipment.

Acquisition Cost. A retrofit numerical-control system will generally cost less to acquire than a comparable new numerically controlled tool. The cost of rebuilding an old tool to retrofit numerical controls is typically quoted at from 40 to 70 per cent of the price of a comparable new conventional tool, although it can range up to 150 per cent (not counting controls cost). A new tool model for numerical control will usually cost 25 to 50 per cent more because of the design differences necessary. Retrofit generally has a clear advantage.

Retrofit is relatively more advantageous for higher priced tools since savings applicable to the machine-tool portion of the system are then a larger fraction of total system costs. Percentagewise, retrofit costs on the order of 5 to 10 per cent less than a new-tool numerical-control system for tools in the $15,000 to $25,000 price class, but would offer savings on the order of 25 to 30 per cent in the $150,000 to $250,000 price range.

Operating Cost. Although retrofit costs less to acquire, anomalously it will cost more to operate than a comparable new-tool system, largely because of amortizing control-equipment costs over the shorter remaining service life for used and rebuilt tools [10] and [11]. This is not necessarily a disadvantage since it provides for earlier recovery of capital investment.

A relatively large investment in control equipment does not imply an inordinate increase in tool-machine hourly operating costs. For example, a $50,000 control system added to a $20,000 tool increases the investment by $2^1/_2$ times, yet the corresponding increase in operating costs is only 32 per cent in the case of the new numerically controlled tool and 44 per cent for the retrofit.

Similar but less extreme results may be noted in estimated operating costs for tools in the higher price brackets, since the cost of control does not increase in direct proportion to the cost of the tool.

Productivity

The net output per unit of machine operating time is the most significant measure of numerical-control performance. Although increased accuracy, reduced tooling, or shortened manufacturing-cycle time may be important, productivity is a universal factor.

Aircraft manufacturing experience which is rapidly becoming available indicates quite certainly that numerical control does indeed offer spectacular gains in machine-tool output, or conversely, reductions in machining time per piece [12–14]. On the average, numerically controlled machining may be more than 300 per cent as productive as conventional methods in standard milling-machine operations, more than 500 per cent as productive in aircraft profiling, and more than 200 per cent as productive in aircraft skin-milling.

Retrofit probably will produce less than a new-tool system, mainly because of the lower attainable feed rates for equivalent accuracy and surface finish. Possible increased down time for maintenance and slightly higher part-rejection rate also may have an effect. Increased productivity, however, results only partially from improvement in those areas where retrofit may compare unfavorably. Rather, the greatest gains stem from the elimination of nearly all data processing and part measurement by the operator and the co-ordination of machine movements so that the number of setups for different operations may be considerably reduced.

These benefits can be achieved in full with retrofit, although equipment performance may be somewhat inferior in comparison with that of a new tool. Because the potential gains achieved through numerical control affect the bulk of the machine time in many operations (up to 90 to 95 per cent in aircraft profiling, for instance) and equipment performance affects the minor portion, the real productive superiority of new-tool systems will be less than performance alone indicates. When this effect and other considerations related to machine capability are taken into account, a retrofitted system probably will be about 10 to 20 per cent less productive than its new-tool counterpart, even though the new tool is assumed to have a 25 to 50 per cent advantage in basic metal-removal capacity.

Economic Feasibility

Each retrofit application should be evaluated on its own merits, since the nature of the machining operation, the type and condition of the tool, and the characteristics of the control system all have important bearing on both the costs and the results.

Financial Benefits. Since funds are often more readily available for modernization or upgrading of equipment than for new acquisitions, retrofit has an advantage in this respect. This is particularly true if portions of the machine rehabilitation or system installation can be accomplished by plant personnel and treated as expense items rather than as capital investment. However, this requires competence in electronics, servomechanisms, and machine tools that not all users possess. Retrofit enables faster write-off of the numerical-control equipment, thus yielding a faster return of investment to offset technological obsolescence.

Conclusions

Numerical controls can be successfully and economically retrofitted to many types of existing machines. Although retrofitted machines will not have quite as good equipment performance as new tools which are optimally designed, they nevertheless will be able to take full advantage of the most important benefits of numerical control as a method. Retrofit can upgrade the performance of old tools by making them more efficient and more accurate through increased automatism of operation, dimensional control, and data processing. While costing less to acquire than a comparable new numerically controlled tool, retrofit permits faster recovery of investment in control equipment, although there is a slight disadvantage implied in operating cost.

Acknowledgments

The material presented in this paper is drawn from a study conducted for the U. S. Navy, Bureau of Aeronautics, Industrial Planning Division [15], whose co-operation in making this information available is gratefully acknowledged. Appreciation also is due the many machine-tool builders and control-systems developers, too numerous to mention individually, whose generous help contributed greatly to the success of the study.

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Benefits and Economies

by William D. Beeby[8]

UNTIL a year ago, most of the claims for numerical control were based on prototype-machine experience, but now a year of actual operating experience with six of these machines at Boeing-Wichita is available.

Numerical control has proved it can reduce costs, reduce lead time, improve quality, reduce tooling, and increase productivity.

Cost Reduction

Since numerically controlled skin mills were not available for production to meet the first deliveries of the B-52G, which required a sculptured-type skin, these were produced on an AMC 24B template-controlled spar mill. This permitted comparison of costs with later production on numerically controlled skin mills.

The actual dollars spent for tooling, planning, and other costs up to actual machining were $18,467 on the spar mills and $1957.50 on the numerically controlled skin mills. Actually, the starting-up cost reduction on this one skin was $16,509.50.

The time required for the first part produced by the spar mill with tracer controls was slightly over 1400 man-hours, and the ninth unit was produced in 750 man-hours. The cost of the first unit on the numerically controlled skin mill was 700 man-hours, but by the fourth unit, the cost had dropped to 300 man-hours and has run consistently between 200 and 250 man-hours through the 30th unit.

The B-52G lower wing panel No. 4 is another example of cost reduction. The first unit cost on the tracer-controlled AMC 24 spar mill was 1070 man-hours, and by the 14th unit had leveled off at 350 man-hours per unit. On the 15th unit, the part was transferred to the numerically controlled skin mill. The first-unit cost was 300 man-hours. It was below 100 man-hours on the 5th unit, and has continued below 100 man-hours through the 29th unit, which is as far as figures were collected.

An $8^{1}/_{2} \times 2^{1}/_{2}$-ft wing-reinforcing doubler was sculptured with several depths and had five lightening and access holes. The first part was completely machined on the numerically controlled profile mill 24 hr after the release of the engineering drawing.

Since this part was required to go into high production it was also tooled to be machined on a Keller-type machine. On the conventional machine, it required five days from the release of the engineering until the first part was machined. On the numerically controlled profile mill, it required 1.2 hr from the time machining was started on the first part until it was complete, whereas on the conventional machine, which was the tracer type, it required 25 hr actual machining before the completion of the first part.

By minor reprogramming after running the first part on the numerically controlled profile mill, it was possible to reduce the machine time to 30 min per part. This was actually an average which included loading and unloading, as 16 parts were produced during each 8-hr shift.

On the conventional mill, it was estimated that the time could be reduced to 6 hr per part; however, at the time machining was discontinued on the conventional machines, the time had been reduced only to 12 hr per part.

The time required for hand finishing on the part as removed from the numerically controlled machine was a total of 10 min, whereas the part removed from the conventional machine required 2 hr of hand-finish time before it was of the quality that could be used in aircraft production.

An example of the cost reduction in the manufacture of tools was a form die which was used to form honeycomb trailing-edge skins. The manufacture of the B-52G required 75 of these form dies. The conventional cost ranged from $3600 to $7200 per die. On the numerically controlled profile mill, the actual cost was $455. This allowed a saving which amounted to 87.4

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[8] Boeing Airplane Company, Wichita Division, Wichita, Kansas. Condensed from ASME Paper No. 58—A-275, "The Operating Experience on Aircraft Production."

per cent. Actually, with 100 dies of this type, it would be possible to save the total cost of the machine, and these dies could be manufactured in a span of ninety days.

Reduction of Lead Time

An example for the reduction of lead time, which is extremely important in the aircraft industry, is that of a structural test specimen. Four of this type of parts were required for structural test. They had to be extremely accurate, and all four parts agree with each other within 0.005 in.

Because of this accuracy requirement, it took 4 weeks to tool up and build these parts by the conventional method. Since this 4-week lead time was very detrimental to our structural test program, it was decided to make the test sections on the numerically controlled profile mill. The parts were programmed and machined and delivered to the structural test unit in four working days with an accuracy of ±0.003 in., and no part varied from the other more than ±0.003 in.

Improved Quality

In every case where parts were transferred from a conventional machine to numerically controlled machines, the quality of the parts was improved and was also held to closer tolerance.

Camera-door tracks programmed for the numerically controlled profiler and machined on it required no hand finishing and were within a tolerance of ±0.003 in., whereas extensive rework was required with tracer-type production.

Thickness tolerance on a sculptured skin produced with tracer control was such that on this 900-lb panel the weight varied 40 lb, compared with 6 lb for numerical control.

Reduce Tooling

The tooling required for one forging on a tracer-type machine was 42 holding fixtures at a cost of $33,772. When this part was transferred to the numerically controlled mill, it was possible to machine it with 14 fixtures, and these 14 fixtures cost $7625. The actual machining time by transferring to the numerically controlled profile mill was reduced by a ratio of 5:1.

Another example was a lower wing panel manufactured on the AMC 24 spar mills. The part required 1600 ft of templates at a cost of $12,554. When it was transferred to the numerically controlled skin mill, the entire part was machined with nine reels of tape at a total cost for preparing the tape of $1094.

Increased Productivity

On lower sculptured panel No. 3, the best conventional machine time was 20 hr per part. When this part was transferred to the numerically controlled machine, 3 hr were required to complete the machining.

Another example was that of a large sculptured rib web which on the conventional machine required 7.8 hr per part, whereas on the numerically controlled profile mill, only 2.5 hr per part were required.

Over 50 different production parts for the B-52G are being machined on the numerically controlled equipment. Experience to date is convincing that numerical control is the coming method of fabrication.

Potentialities and Problems

by William M. Stocker, Jr.[9]

One large machine-tool company has completed a very intensive market survey which indicates that in about five years the market for *discrete-positioning* numerical-control systems will be about $72 million per year. To accept figures of this size, one must recognize the relationship between numerical control, the machine tool, and the manufacturing operation. First and foremost, numerical control is a form of tooling. It is a versatile, accurate, multipurpose tool that can be supplied as an inherent part of the machine tool or as an attachment.

Currently, of the fifty-or-so systems in various stages of development and use, most are discrete-positioning. Fewer than a dozen offer continuous-path control. Discrete-positioning systems are not necessarily simple but generally they offer fewer development and manufacturing problems, lower cost, and much broader immediate application than continuous-path systems.

Numerical control is a basic process-control concept, an advance over the use of cams, templates, patterns, and other measuring, sequencing, and process-timing devices. It can be used in plating, welding, riveting, assembly, pressworking, and many other nonmachining operations as well as in controlling any machine tool requiring repetitive operator skill, frequent setup, or complex tooling, as a factor in production. It almost certainly will find some use in drafting and lofting.

Automatic controls, right now, are providing industry with a robot work force. People are prone to expect these modern-day slaves to work unceasingly and without error, simply because they are machines. This attitude just is not practical. No mechanism, human, animal, or mechanical can perform continuously without some entropic decay. The important questions are: What ratio exists between up time and down time; how many acceptable parts are produced when the mechanism is operating; and what is the ultimate cost per piece?

However, reliability is a function of complexity—of the number and relationship of the components in a system. Generally speaking, discrete-positioning, numerical-control systems are at least an order of magnitude less complex than the path-control systems. Hence point-to-point controls are not as subject to failure as the continuous-path controls. Some of the worries keeping people from buying simpler systems stem from the latter. Of course, designs must be sound for the desired application.

Does the Equipment Justify the Cost?

Cost savings with discrete-positioning numerical control are reported as ranging between 50 and 80 per cent over conventional equipment, depending upon the amount of labor, degree of skill, and extent of tooling required. Many users are recovering their investment in less than 2 years—if they maintain fairly high utilization. Fringe savings in such things as the ability to standardize components, lower tool breakage, regain fixture-storage space, improve scheduling, reduce inspection time, and to make product assembly easier are continuing to astound users.

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[9] Senior Associate Editor, *American Machinist*, McGraw-Hill Publishing Company, Inc., New York, N. Y.

Condensed from ASME Paper No. 58—A-293, "Experience With Discrete-Positioning Numerical Control in the Aircraft Industry."

This kind of performance more than justifies the cost of these installations. While some unhappy users undoubtedly exist, they are not to be found among the owners of established systems. But, one note of caution —utilization rate must be maintained. Machines at these prices pile up charges quickly when they stand idle.

Will Management Accept the Concept?

Management is not against numerical control, or anything else that earns a profit. It just wants to be shown. Some of the areas of concern are: Will we wind up with a number of nonstandard, incompatible systems? Can we find enough work to keep the equipment busy? How much time and money will it cost to train my employees? Will maintenance specialists have to be hired to keep the units working?

Maintenance of most systems is not a serious problem. Training programs seldom require more than a few days. Most users have found more practical jobs for their equipment than the machine-hours available. Compatibility is still a cause for some concern but the problem is much smaller for discrete-positioning systems than it is for path control. Most point-to-point units operate independently. Also, certain basic standards, such as input media, are now being established. On the whole, none of these problems is serious for carefully selected systems, unless lack of adequate information creates fear.

What About Retrofit?

Retrofits, or the application of a control system to an existing machine, generally can be classed in two forms: (*a*) Systems requiring rebuilding the machines ways, screw drives, power supply, and so on; and (*b*) application of a complete table, drive, and control system to the frame of an existing machine.

Substantially all of the people questioned believed that retrofit in the first sense is inefficient; that it is likely to be too expensive for closed-loop performance to tight tolerances and is often a poor fit. Again, numerical control won't make a bad machine better. Design of an integrated machine-and-control system is generally preferred.

On the other hand, retrofit with a unitized positioning table seems much more practical. Of course, it should be applied to a carefully selected, first-class machine. One important observation was that when one considers spending the money for a control system, an equipment study will quickly prove the impracticality of using it on an inefficient machine. Engineered machine-and-control systems usually are most efficient.

Conclusions

The field of numerical control is too new to have produced much in the way of operating data that will document its capability. Data available now will be greatly multiplied by the end of 1959 as more units are installed and learning curves stabilize to production levels.

From preliminary results it appears that aircraft applications of discrete positioning have an exceedingly good future; that the concept parallels aircraft production problems. Uses for discrete positioning include drilling, tapping, boring, jig boring, turning, shaping, roll-flowing, stretching, turret punching, coil winding, riveting, spot welding, flame cutting, and welding, drafting, lofting, and inspection.

Along with savings of 50 to 80 per cent in labor and scrap reduction, the technique offers substantial savings in tooling, lead time, and other fringe benefits— especially for short runs. Prototypes can be produced at much more practical costs.

Maintenance of these systems is not a critical problem when the system is applied properly. Most of the criticism resulting from maintenance and debugging problems can be traced back to untried prototype installations. Today, most manufacturers of positioning systems build, operate, and debug their equipment in their own plants before delivery to their customers.

The 1-in-wide, 8-channel, punched-paper tape is generally preferred as the external information-storage medium. Punched cards are the second choice—where the ability to rearrange or change the cards offers an operating advantage.

The best sources of education for potential users are the control and machine-tool builders and the people now using systems.

Air Force Participation

by William M. Webster[10]

THE possibility of using numbers, expressed as holes punched in cards or tape, to define and control multiple motions of a machine tool was first presented to the Air Force in January, 1949, by John T. Parsons of the Parsons Corporation, Aircraft Division, Traverse City, Mich., and resulted in a development contract with Parsons on June 15, 1949. The development of the punched-card or tape-actuated servomechanism was subcontracted to the Servomechanisms Laboratory of the Massachusetts Institute of Technology.

Design Philosophy

Basic studies on servomechanisms resulted in the conclusion that computations for groups of tools should be performed on a relatively large digital computer having a permanent output-storage medium such as magnetic tape or photographic film. The major task was defined as developing conversion equipment to translate stored information into active signals for operating the machine. Equipment was needed to measure distance along the three co-ordinate axes to an accuracy of approximately 0.001 in. and to provide resolvable signals for several subdivisions of each 0.001 in.; equipment to drive the machine members; equipment to register incoming signals, table positions, incoming feed-rate data, to make subtractions between input and output signals, and to convert digital information into continuous information for operating the drive equipment.

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[10] General Engineer (Automatic Control Systems), Manufacturing Methods Branch, Industrial Resources Division, Headquarters, Air Materiel Command, Wright-Patterson Air Force Base, Ohio.

Condensed from ASME Paper No. 58—A-162, "Continuous-Path Numerical Control."

As work progressed on component design and development, a Government-furnished Cincinnati Hydro-Tel milling machine was substituted for the planer-type machine originally specified. When the Parsons Corporation withdrew from the contract, M.I.T. was established as prime contractor on February 1, 1951.

By January, 1952, the director was completed and 487 hr of reliability and life tests were conducted during the month. Two months later the machine and control systems were completed and operating on a three-axis basis. Intensive check and operational studies followed, with parts cut, engineering studies, marginal checks, and adjustments made. By the end of the year, liaison work to spur an active interest by industry in the potentials of numerical control had succeeded in producing much curiosity but no tangible results. Requests for information and reports had been received from Belgium, Canada, France, Italy, Japan, and Switzerland.

Industrial Development

In 1953, a portion of the M.I.T. effort was diverted to permit the staff to undertake design and development work under industrial sponsorship by the Giddings & Lewis Machine Tool Company, Fond du Lac, Wis.

By May, 1954, most aircraft companies were proceeding with plans to use numerical control and to seek funds from the Air Force for work on applications and equipment. The development work on numerical control at that time represented an investment of a half million dollars of public funds.

The first three-axis numerically controlled milling machine for aircraft production patterned after the M.I.T. development was approved for procurement by the Glenn L. Martin Baltimore plant facilities contract.

Air Force support of the development project at M.I.T. was withdrawn upon completion of the contract coverage on June 30, 1955, because it was believed that the merits of the system and its development status were such that industry could and would accept and exploit it to an extent commensurate with its potentialities without further governmental sponsorship, although this did not prove to be the case at that time. While a definite lull in government sponsorship was imposed upon the advancement of numerical control, a very significant development was occurring in a distinctly unrelated area. This was the inauguration of a program to "bulk buy" long-lead-time machine tools. This program was later designated as the "Machine Tool Modernization, Selective Augmentation, and Replacement Program." This program provided a means whereby numerically controlled machines could be introduced quickly and effectively into the aircraft industry. By the end of 1955, contracts were established for the procurement of 63 numerically controlled skin and profile-milling machines. With this commitment to numerical control by the Air Force, a new emphasis was placed upon the development of better data-generation and processing techniques to support this equipment.

New Contract with M.I.T.

In June, 1956, a new contractural agreement was placed in effect with M.I.T. for the development of automatic-data-processing techniques to specifically provide input information for numerically controlled machines. The endeavor is continuing and its status is reported in the following article.

The original procurement of 63 numerically controlled machines was subsequently augmented by the conversion of 42 profile mills from template to numerical control. The total of 105 machines is composed of 24 skin mills and 81 profile mills. The skin mills range in size from 8 × 30 ft to 12 × 45 ft, while the profile mills range from 4 × 4 ft to 4 × 14 ft. Four different numerical-control systems are included. Two of these operate from information recorded on magnetic tape and require auxiliary equipment for tape preparation and recording. To support the latter systems, a total of 9 directors and 22 tape-preparation desks were procured. As of July 30, 1958, 3 directors and 12 tape-preparation units had been delivered. The grand total cost for the original development of numerical control, and the procurement of the foregoing numerically controlled machines, and auxiliary equipment, is on the order of $30,000,000.

Operational Tests

Each piece of equipment is subjected to a rather comprehensive operational test as a condition of acceptance. The tests for the skin and profile mills normally require 4 or 5 days to complete. Static and physical checks include dimensions, motion travel, table flatness, squareness, and parallelism of movements with respect to table and T-slots, spindle runout, pivot points, positioning accuracy, and so forth. Dynamic and cutting tests include maximum horsepower, maximum feed rate, and other cutting tests designed to demonstrate fully the ability of the machine and control system to produce to specified tolerances and surface finishes under a variety of conditions. Each new combination of machine and control system is checked by an inspection team normally composed of two members from the Manufacturing Methods Branch and two members from the aircraft industry. As of this writing, these teams have conducted a total of twelve such tests and a few remain yet to be accomplished. Tests on subsequent like machines and control systems are delegated to local government quality-control personnel.

The Air Force Approach

Development work has been concentrated by the Air Force upon continuous-path control rather than discrete-positioning systems primarily because of the potentiality in providing a highly flexible and accurate means for specifying and producing airfoil and other complex configurations peculiar to aircraft components. Furthermore, solutions found to the problems associated with continuous-path control would probably apply equally well to discrete positioning.

The Air Force is happy to have had the opportunity for participation in the development of a philosophy that it is freely predicted will have a long and lustrous life.

The APT Joint Effort by Douglas T. Ross[11]

As DESCRIBED in the preceding article, the Servomechanisms Laboratory at M.I.T., under Air Materiel Command sponsorship, developed the first numerically controlled milling machine and, using the M.I.T. Whirlwind computer, the first library of subroutines and a pilot model of the first automatic programming system for numerical control. Under continued Air Materiel Command sponsorship, the Laboratory undertook an intensive research program in the fall of 1956 for the development of automatic programming systems for the production of three-dimensional parts on 3 and 5-axis milling machines. This work has led, through the APT Joint Effort, to the most ambitious effort to date for automatic programming development. The Joint Effort is sponsored by the Aircraft Industries Association and is open, on a mutual-support basis, to all organizations with a firm interest in numerical control.

In early 1957, at about the time when the M. I. T. Project had completed its formulation of the APT System concept (described on pages 59-60), a brief report on progress was made for the information of the members of the Subcommittee for Numerical Control, which had been formed by the Aircraft Manufacturing Equipment Committee of the A.I.A. to study the effect of numerical control on the aircraft industry.

The new analysis and comprehensive approach of the APT System concept were enthusiastically received by the Subcommittee, and at a later meeting detailed discussions were held to investigate whether the APT System approached could be used to meet the aims of the Subcommittee with respect to utilization of numerical control. The problem of compatibility is of paramount importance to the aircraft industry owing to the extensive use of subcontracting, especially in the airframe industry. Great savings are possible if a standardized procedure is available for transmitting specifications from one plant to another. In the case of numerical control, since virtually all the important production data are contained in the numerical-control manuscript, it appears highly desirable to attempt standardization of manuscript format, so that vital production information for parts to be produced by numerical control can be transmitted efficiently and without extra processing. At the time of the initial meetings, the large number of different types of machine tools and directors in existence, or soon to be delivered, made standardization at the machine-tool-director language level seem unrealistic. However, since the APT System concept includes provisions for preparing cutter-center output in any one of a number of director-language codes, it appeared that, if an industry-wide APT System and part-programming language could be agreed upon, the APT System could produce control tapes for any one of the many machine-tool systems. It was decided to pool computer-programming manpower and resources to produce a complete APT System for industry-wide use. Interestingly enough, those aircraft plants which already had developed their own automatic-programming systems were among the staunchest supporters of the joint effort, even though they have continued to expand and develop their own systems. A survey disclosed that almost all of the interested companies either already had, or planned soon to have, an IBM 704 computer so that it was planned that the system should be coded for that machine. It was decided that the over-all co-ordination of the project would be the responsibility of the M.I.T. Servomechanisms Laboratory.

Very early in the planning of the Joint Effort it was decided that developments should take place in successive phases. The first completed system, called the 2D-APT-II Phase I System, is the combined results of the work of over thirty computer programmers, and a field trial version was shipped by M. I. T. to 17 participating companies for shakedown tests in April, 1958. Difficulties with the system have since been corrected and it is now capable of performing real service for a limited but very useful class of parts.

Since the primary function of the AMC-sponsored M.I.T. project is research in automatic programming rather than development, it was felt that after the Phase I System had been launched effectively, the co-ordination of the joint effort should be taken over by an industry-sponsored committee and the M.I.T. project would then revert to ordinary membership in the Joint Effort.

In order to insure that the future developments were launched on a firm foundation, however, it was felt that a full set of documentation should be prepared. The documentation work will consist of about six separate volumes and will completely describe the system from the part-programming language through to operation, debugging, and modification of the system.

The transfer of co-ordination responsibility from the M.I.T. project to the APT Project Coordinating Group sponsored by the AIA took place in June, 1958. The modification of the field-trial programs has been carried out under the direction of O. Dale Smith, North American Aviation, Los Angeles, who is Chairman of the APT Project Co-ordinating Group. Members of the M.I.T. project have concentrated on editing and preparing the final Phase I documentation. During the same period, a number of proposed Phase II features were added to the field-trial system to make a more usable Phase I System.

Future of the APT Joint Effort

It has been mentioned previously that the APT effort has been envisaged from the beginning as a continuing evolutionary process in which continually better procedures for automatic programming will be added to the initial Phase I System.

Although the present system is large and is rapidly exceeding the substantial capacity of the IBM 704 computer, the concepts of an APT System do not necessarily require a large computer. It is hoped that through the Joint Effort these techniques will be employed on other computers as well, and that output routines for all numerical-control director systems will be added. ●

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[11] Head, Computer Applications Group, Servomechanisms Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

Condensed from ASME Paper No. 58—A-236, "A Progress Report on the 2D-APT-11 Joint Effort for Automatic Programming of Numerically Controlled Machine Tools."

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD

Beryllium Forgings

THE FIRST successful large closed-die forging of the exotic metal, beryllium, has been produced at the Wyman-Gordon Company—United States Air Force plant at North Grafton, Mass.

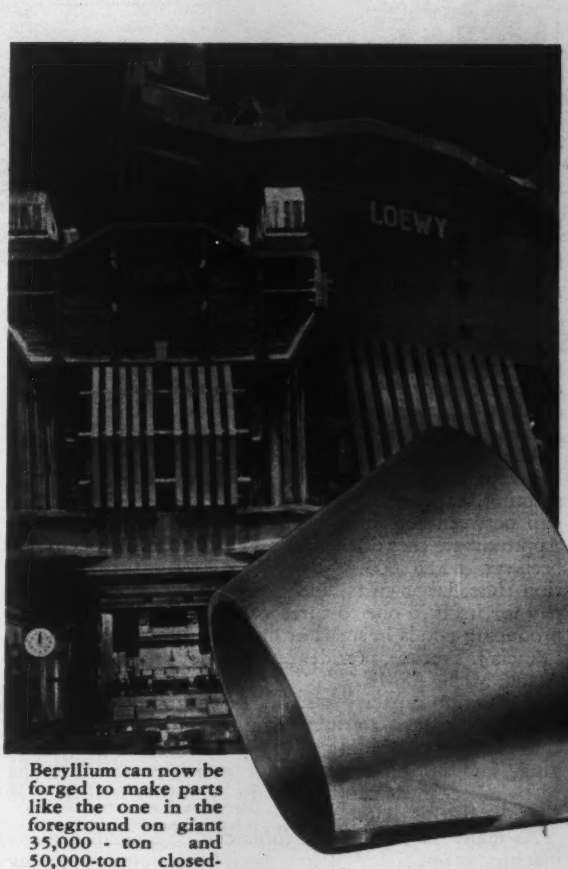
Announcing his company's recent achievement in overcoming the one critical impediment to the use of beryllium in space flight—its brittleness—Robert W. Stoddard, president, said that ". . .beryllium may now be truly considered a structural engineering material for future space flight. It is anticipated this will have far-reaching effects in propulsion systems, missile applications, and space vehicles."

The importance of this forging development of beryllium particularly for use in space travel, derives from the fact that beryllium's lightness, in addition to its other unusual space-travel qualities, reduces the ratio between the weight of a vehicle and its power with the result that it affords added fuel load and increased range of a missile, rocket, or airplane.

The beryllium forging meets a Government need for a space metal which must withstand high and low temperatures, severe demands of nuclear compatibility, thermal shock, corrosion resistance, and radiation damage.

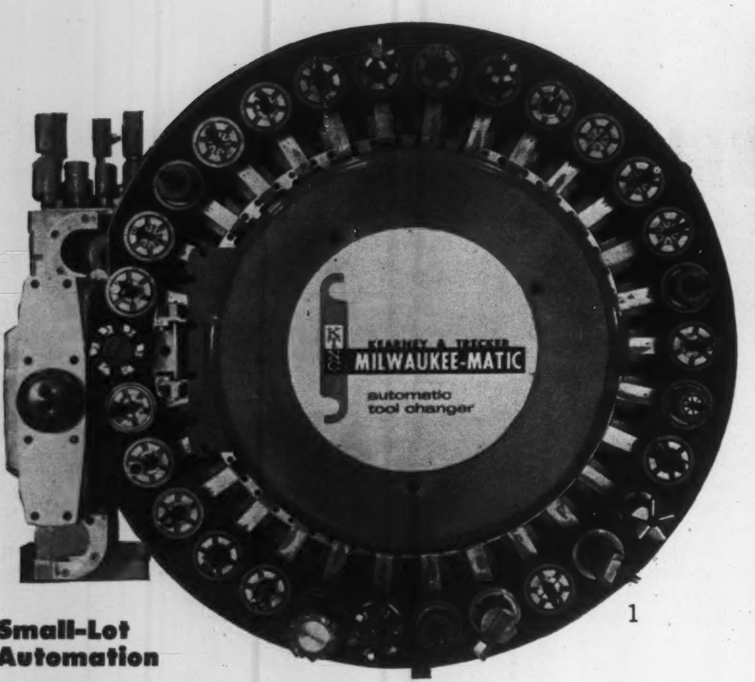
"Another problem which has been overcome in principle by this new forging process is that of producibility," Mr. Stoddard said. "To date, smaller parts have been machined from rough blocks produced under little or no pressure subjected to high temperatures for many hours and, in many cases, even days. The Wyman-Gordon forging method produces a part in a matter of seconds—at most, minutes. This is a tremendous advantage today, and the importance of this can be easily realized, especially should there be a national crisis."

"Beryllium," Mr. Stoddard said, "has a number of intrinsically interesting and important properties. Its density is as light as magnesium alloys. Its modulus of elasticity is one and one-half times that of steel. Its behavior in certain types of radiation makes it singularly important in a variety of nuclear devices. Its heat capacity is exceedingly high. It has moderate strength but an excellent strength-to-weight ratio. However, there has been a formidable barrier to overcome. . .its brittle behavior. This has been a major obstacle to the widespread use of the metal and has been the cause of many expensive development programs and additional cost to already high-priced components in weapon systems.



Beryllium can now be forged to make parts like the one in the foreground on giant 35,000 - ton and 50,000-ton closed-die forging presses

"A closed-die forging technique has been developed at Wyman-Gordon that is capable of eliminating this brittle behavior and results in a much more ductile material. It also is capable of producing shapes that require a minimum of machining. These shapes, so produced, now have the ductility and isotropy of the order of the strong aluminum alloys while maintaining the inherently desirable properties of the metal (beryllium)."



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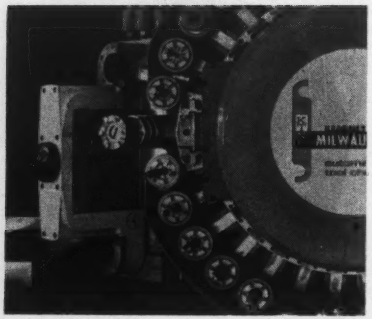

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Automatic tool changing is accomplished with a rotary tool magazine: 1 Loaded with 30 different cutting tools each chucked in a coded holder. 2 The tool-change arm and selected tool holder in the first step of the 8-sec changeover. 3 In the transfer position. 4 The fully extended tool arm simultaneously grips the tool holders in both the magazine and the spindle. 5 Both tools have been removed from the spindle and the magazine socket is in the process of making the actual change.

Small-Lot Automation

Flexible automation is economically feasible for small-lot manufacturers with a versatile, automatic-tool-changing, tape-controlled combination machine developed by Kearney and Trecker Corporation with General Electric Company supplying the program controls.

The new combination machine, called the KTNC Milwaukee-Matic,—which performs milling, drilling, reaming, tapping, and boring operations—bridges the gap between job-shop mechanization and automation. Approximate cost of the machine and control system has been set at $120,000. "By reducing setup time, production time, labor costs, and inventory, this machine can pay for itself in one to three years for any manufacturer producing goods in small or medium lots," according to Francis J. Trecker, president of Kearney and Trecker, and Assoc. Mem. ASME.

Production capacity is equal to that of several conventional machines. By minimizing setup and positioning time, and by combining milling, drilling, reaming, tapping, and boring functions in a single machine, the Milwaukee-Matic can be kept in operation well over 75 per cent of the time.

As many as 31 different tools can be loaded into the machine at one time—30 in a specially designed revolving tool-storage drum and one in the spindle. There are 31 different combinations of 31 tools, ranging in size up to $2^{5}/_{8}$ in. in diam, that can be utilized by the machine, making a total of 961 tools.

To make tool changes, a transfer arm automatically pivots out from its position beside the drum, simultaneously removes the tool from the spindle and a new tool from the tool-storage drum; rotates, simultaneously inserts the new tool in the spindle and the other in the drum; and returns to its normal position. Less than 9 sec are required for tool changes.

The General Electric control system makes the tool selection and directs the workpiece transfer. If the programmed tool has not been loaded into the drum by the operator, the drum will continue to revolve until it is stopped and the proper tool is inserted. Engineers pointed out that tools carry a binary code and can be placed at any position within the drum regardless of the sequence in which they are to be used. Mechanical "fingers" feel the tools and signal the control to stop the drum when the desired tool is in position to be removed by the transfer arm.

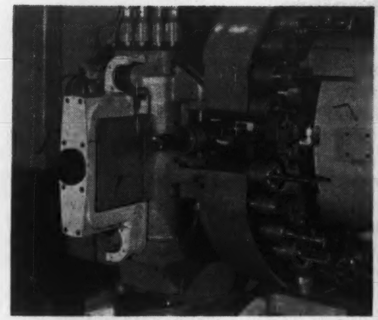
In operation, the worktable is automatically indexed to present workpiece surfaces to the spindle. The spindle moves longitudinally, vertically, and to depth. Feed rates range from 1 to 99 in. per min and are selected in increments of 1 ipm. Spindle speeds from 100 to 4000 rpm are selected in increments of 10 rpm.

As the spindle is used for tapping, a complete reversal requires 0.1 sec at 100 rpm and 0.4 sec at 400 rpm. Acceleration of the feed drives to 100 ipm is accomplished in 0.05 sec. Where feed rates are not specified, positioning is done at 200 ipm.

The Milwaukee-Matic is equipped with a numerical control system developed specifically for this application by General Electric's Specialty Control Department, Waynesboro, Va., which makes the entire machine automatic. It not only directs positioning of the worktable and three-axis spindle; it also controls tool selection, tool changing, spindle speed, feed rate, and auxiliary functions such as turning coolant on and off and shuttling the work between index table and load and unload stations.

Slope and arc cutting can also be performed by the machine. This feature does not introduce control complexity, nor difficult tape-preparation problems.

The machine will perform circular cutting of radii from 0.1 to 9.9 in., in radius increments of 0.1 in. The maximum error on arc milling is ± 2 per cent of arc length. Maximum speed for arc and slope cutting is 30 ipm for radii between 0.5 and 9.9 in. According to de-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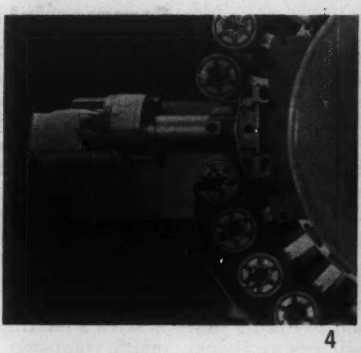
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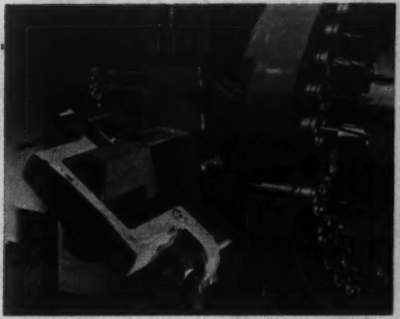
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sign engineers the control permits users to mill clearances, "walk" around joint faces, and perform similar jobs where high accuracy is not required.

A push of a button is all that is required to put the versatile combination machine into operation. Once started, it will continue to function automatically until the programmed job is completed. While the machine is in operation, the operator is free to prepare the next workpiece for production and to select the necessary tools required if a new part is to be machined. This makes possible a complete change-over in minimum time.

Spindle-speed and feed-rate commands are selected by precision resistor networks for servo control from tachometer feedback. A small instrument analog computer approximately 10 × 10 × 20 in. does all the interpolation required for arc and slope generation. This process is started, controlled, and stopped automatically from four instruction blocks on the tape.

Position commands in increments of 0.0001 in. for longitudinal and vertical and 0.001 in. for depth are stored as discrete points in the form of sine and cosine voltage ratios. Course-position feedback is from synchros; fine-position is from precision scales on the longitudinal and vertical positions.

Surfacing Zirconium-Alloy Sheet

In the assembly of zirconium-clad elements for atomic reactors, a method of preparation for the surface of the zirconium sheet was sought by Hugh N. Dyer and R. A. Leggett, product-engineering department, Behr-Manning Company, Troy, N. Y., which would leave an uncontaminated flat surface to permit satisfactory bonds with the gas-pressure bonding process.

In this process, the reactor-grade Zircaloy-2 sheets are surface finished, degreased, detergent washed, rinsed, and assembled into a protective container which is evacuated and sealed. The sealed assembly is then subjected to helium pressure at an elevated temperature in a high-pressure autoclave. The high pressure brings the mating surfaces into intimate contact and bonding is effected by diffusion and grain growth across the interface. Since this bonding process involves only slight deformation as compared with roll cladding or extrusion cladding, the method used to prepare the Zircaloy surface has a significant influence on bond quality.

It has been found (see S. J. Paprocki, E. S. Hodge, and C. B. Boyer, "Preparation of Reactor Components by a Gas-Pressure Bonding Technique," Proceedings of the Second Geneva Conference on Peacetime Uses of Atomic Energy) that pickled Zircaloy surfaces are slightly contaminated and do not bond satisfactorily in the alpha-phase region; that grit-blasted surfaces contain embedded grit and give contaminated and weak bonds; that grain growth does not occur across the bond between cold-rolled surfaces, even with clean surfaces; and that annealed machined abraded surfaces bond perfectly.

Good bonds are obtained by any process that produces a uniform surface roughness above approximately 80 microin. RMS, provided the surface is uncontaminated by embedded abrasive grit or other material, and that the surface finish is readily reproducible. These conditions can be met most economically by coated-abrasive belt grinding if careful standardization and control of the abrading process are maintained.

The specimens in this study were composed of small plates of Zircaloy 2 of reactor grade that had been belt abraded under varying conditions. The variables investigated were abrasive belt speed, type of grinding fluid, type and size of abrasive gain, and total amount of metal removed. Both hot and cold-rolled Zircaloy were used in the study. Pressure bonding was performed at 1550 F for 5 hr at 10,000 psi. The bonds were evaluated metallographically to determine the amount of bond-line contamination and the extent of grain growth across the original bond interface. They were also peel tested by driving a chisel into a V-notch at the bond interface, and tested in steam at 750 F.

The samples were abraded on an abrasive-belt surface grinder using an X-serrated, 80-durometer rubber contact roll. The abrasive-belt speed was varied from 1100 to 5500 fpm and the two grinding fluids investigated were a heavy sulfur-chlorinated cutting oil and tap water. The Zircaloy was fed through the grinder at 4 fpm and the amount of metal removed was 0.001 to 0.005 in. per side. The stock removal was in the order of 0.0005 to 0.001 in. per pass through the machine, with belts coated with both aluminum oxide and silicon carbide.

On the basis of the results, machine-abrasive belt finishing appears to be a satisfactory technique for preparing Zircaloy surfaces to obtain good metal-to-metal bonds by the gas-pressure process. Careful standardization and control of the abrading process are necessary if bonds of good quality are to be obtained consistently and economically.

In the grinding of Zircaloy, an extremely hot, intense spark is produced and certain precautions are necessary in order to prevent fires when grinding with an oil-base grinding fluid. Low belt speed helps to reduce the intensity of the spark, and a heavy flood of oil directed at the grinding point quenches the spark rapidly. An oil having a high flash point, above 350 F, is required.

Test Range for the X-15

Mile-a-second X-15 research airplanes flying at 100 miles altitude, will be tested on a new High Range in the Nevada wastelands developed and built by the Electronic Engineering Company, of Santa Ana, Calif. It will provide the National Aeronautics and Space Administration with 600,000 answers per sec to electronic questions on the safety of the pilot and the condition of the airplane when the North American Aviation rocket-powered research airplane drops from a B-52 bomber and roars into space.

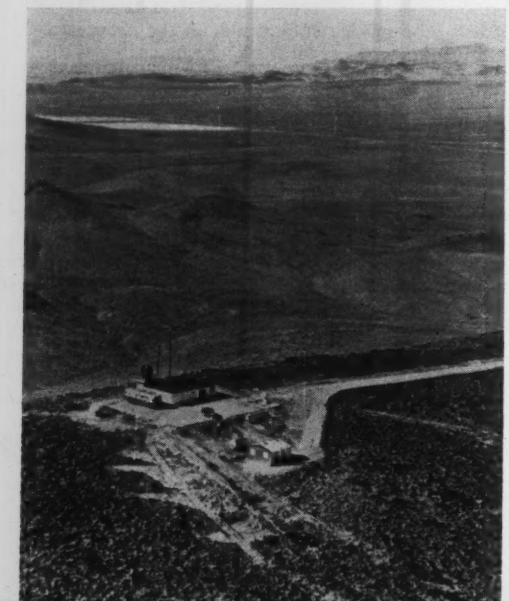
Work began on the test range in 1956 and was completed in December, 1958, at a cost of more than $2 million. The Electronic Engineering Company also developed and constructed similar test facilities at Point Mugu, now a part of the Pacific Missile Range, and at Cape Canaveral, the Atlantic Missile Range.

A continuous flow of electronic information is provided by the range so that flight engineers and scientists at any of three stations on the ground may instantly observe everything from the heartbeat of the pilot to the skin temperature of the airplane. Simultaneously, radars and plotting boards pinpoint and trace the course of the research vehicle.

A constant-contact communications system enables the pilot and all three of the ground stations in California and Nevada to be in touch at all times. If for any reason the pilot cannot contact one ground station, the other stations can receive his voice and relay it immediately via telephone line. All of the UHF radio transmitters and receivers at the three stations are on the air simultaneously and at the same time are interconnected via long-distance telephone line. This system required nearly 3000 miles of long-distance line to insure constant communications.

Data from a single flight can be fed from the High Range equipment and processed in about 30 hr using two operators. Formerly such a procedure, using photo-panel methods and manual data reduction, required more than 30 days and nearly a dozen or more data interpreters. Aeronautical design engineers sometimes had to wait for more than a month before being able to make a design decision based on flight tests.

A new High Range in the Nevada wastelands will provide 600,000 answers per second on condition of plane and pilot in the X-15 with a constant-contact communications system



Commercial Rhenium

Commercial production of wrought rhenium rod, wire, and strip is being scheduled by the Research and Development Department of Chase Brass and Copper Company, a subsidiary of Kennecott Copper Corporation. Current applications of the comparatively new metal, and research into new uses, have increased its consumption by over 400 per cent in the past few years. Although a rare metal, sufficient quantities are available to warrant its consideration for important commercial applications. Potential production capacity of the United States has been estimated at 20,000 to 30,000 lb a year.

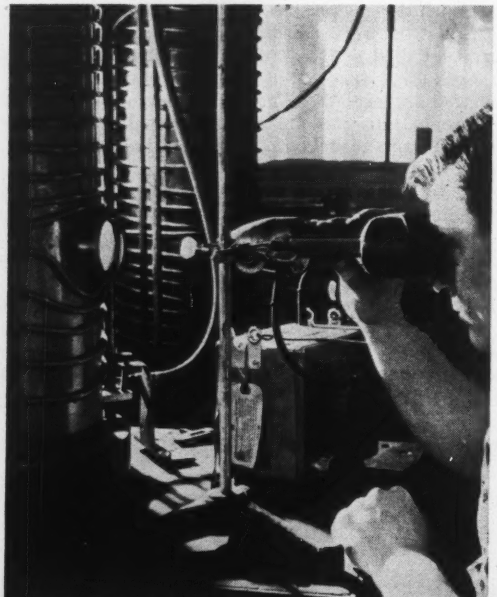
With a melting point of 5756 F, surpassed only by one metal, tungsten, and one nonmetal, carbon, rhenium finds its most important present applications in the highly critical measurement and control aspects of high-temperature technology. Thermocouples of rhenium and tungsten make possible measurement and control of temperatures up to 4500 F, far beyond the temperatures achieved by more conventional metals. Tensile strengths are as high as 350,000 psi. Vickers hardness for strip is 525, tensile 285,000 psi, and elongation is 2 per cent in 2 in.

While not a structural metal, rhenium holds great promise as a possible welding material for molybdenum, either in its pure state or alloyed with molybdenum, and electrical properties are superlative.

Rhenium metal is produced at Chase through powder metallurgy. Extremely pure rhenium powder is pressed into bars at 25 to 30 tons per sq in. These bars with a theoretical density of about 45 per cent are then presintered at 2200 F under vacuum. Final step in production of the metal is resistance sintering at 5000 F in a hydrogen atmosphere.

All fabrication of rhenium metal is done by cold working, which is extremely difficult because of the rapid rate of work hardening of the metal. Rolling, swaging, and drawing of rhenium require frequent anneals between reductions, and thus annealing constitutes a major part of the work in production of wrought forms. Hydrogen gas or "annealing hydrogen" is normally used as a protective atmosphere.

Sintering temperatures of 5000 F are controlled with an optical pyrometer in producing rhenium bars of high density and quality. These are fabricated into rods and into wire for thermocouples.



Specific Heat of Plastics

An adiabatic calorimeter, Adiacal, which determines the specific heats of various plastics and other nonmetallic materials in the 25 to 160-C range has been developed in the Non-Metallic Materials Division, Chemistry Research Department of the U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

With the increasing replacement of metals by plastics, accurate data on thermal properties have become important, and little accurate information was available.

The development of Adiacal has made it possible to determine specific heats and thermal diffusivity for a large number of plastic materials. The data obtained are also useful for determining some of the other thermal properties.

Adiacal consists of three concentric cylinders each closed at the top and bottom. A sample of the plastic material under study is enclosed in the innermost cylinder; this sample contains an embedded resistance coil and a thermocouple. Electrical energy is supplied to the resistance coil so that the temperature of the plastic sample increases at a uniform rate. This increase in temperature is measured by the embedded thermocouple. While the sample is slowly and uniformly increasing in temperature, adiabatic (no transfer of heat) conditions are maintained by carefully heating the inner cylinder of the calorimeter at such a rate that this cylinder, and the plastic sample contained in the innermost cylinder, are at the same temperature. This sameness of temperature prevents heat exchange between the plastic sample and its environment. The adiabaticity is controlled by an electronic system (based on differentially connected thermocouples) which automatically makes the necessary temperature corrections.

The rise in temperature of the plastic sample is measured at 300-sec intervals, and its specific heat is calculated as a function of temperature. It is possible to determine not only the increase of the specific heat with increasing temperature, but also the melting point of many thermoplastic materials, and the second-order transition (or point at which the plastic becomes rubbery) of many thermosetting materials. This latter property is very important because of its relation to the mechanical properties of the plastic.

Studies are also being conducted at NOL on the basic structures of polymers, using data obtained by Adiacal. For example, it has recently been found that the specific heat and melting point of polyethylene are functions of how the polyethylene has been polymerized. Specific heat data, together with other information, can be used to study the structure of this plastic.

Materials Briefs

▶ Polyisoprene in Commercial Production

Polyisoprene rubber is now in commercial production by Shell Chemical Corporation at a price competitive with natural rubber. The U. S. Rubber Company has begun initial production of polyisoprene truck tires in the 7.50–20 size and will expand to additional sizes as the supply of the synthetic increases.

Five tons a day are currently being furnished to U. S. Rubber and effective capacity is expected to increase to 15,000 to 20,000 tons annually on a steady basis. Although passenger-car tires have been made mostly of GR-S synthetic rubber, until polyisoprene was made available, large truck tires continued to be made of natural rubber. Their heavy loads and heat build-up demanded the tougher, cooler-running natural product.

Crepe rubber, used in footwear, is expected to provide another market for polyisoprene, which does not require addition of carbon black for strengthening. It can be made in any plasticity required, is easier to process than plantation rubber, and is suitable for use in flexing or twisting operations, and as skim coating for the plies of conveyer belts.

▶ Vibration-Damping Material

A more efficient and less expensive vibration-damping material especially designed for high efficiency in the temperature range 20 to 180 F is available in sample quantities from the Industrial Division of Armstrong Cork Company. The new product is called Armstrong vibration-damping material #881-658FF.

Vibration reduction in sun-heated aircraft fuselages which are subjected to large driving forces at take-off power, and reduction of noise from heavy-duty industrial gear-boxes made of welded plate are among the applications.

▶ Chemical and Heat-Resistant Viton Hose

A flexible hose, which can be used for short periods at temperatures up to 600 F, lasts almost indefinitely at 350 F, and resists extremes of chemical attack, is being marketed by Thermoid Division, H. K. Porter Company, Inc., Philadelphia, Pa.

The hose is constructed of du Pont Viton with high strength and resistance to abrasion contributed by a jacket of Dacron polyester fiber. Minimum burst strength is 600 psi, life is in excess of 2400 hr at 400 F.

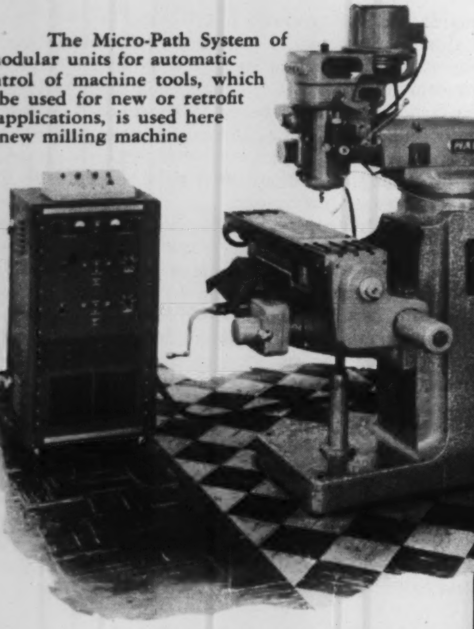
The new hose can be used with jet fuels, highly aromatic mixtures such as internal-combustion fuels, and petroleum-based lubricants at temperatures as high as 400 F. It resists penetration by tetraethyl-lead compounds used in aviation and motor gasoline, and has exceptional resistance to such solvents as carbon tetrachloride, benzene, toluene, and xylene, as well as to concentrated acids and bases.

▶ Fatigue Properties of High-Strength Steels

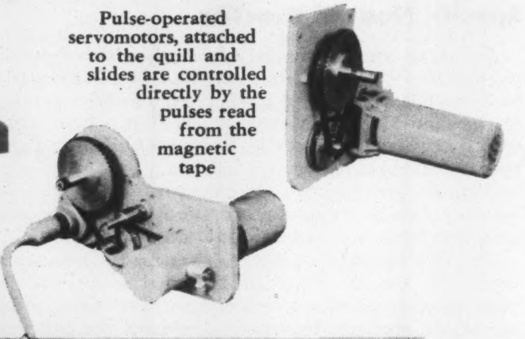
Retained austenite in the matrix of high-strength steels lowers fatigue strength, according to experimental results of recent NBS research. The results also showed that fatigue stressing transforms retained austenite to untempered martensite, which probably causes the deleterious effect.

These findings were made during an investigation performed on four different low-alloy steels with carbon content ranging from 0.44 per cent to 1.06 per cent. The results of this research should have practical applications in the processing of high-strength steels used throughout industry, and in the choice of steels for critical parts such as missile casings and aircraft structures.

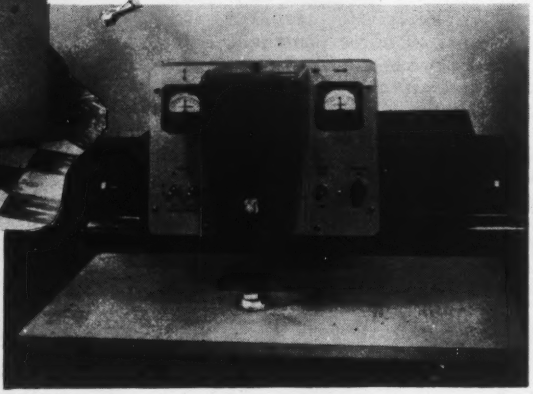
For further technical information see: H. E. Frankel, J. A. Bennett, and W. A. Pennington, "Fatigue Properties of High-Strength Steels," *Trans. ASM*, preprint no. 121, 1958.



The Micro-Path System of modular units for automatic control of machine tools, which can be used for new or retrofit applications, is used here on a new milling machine



Pulse-operated servomotors, attached to the quill and slides are controlled directly by the pulses read from the magnetic tape



A stylus programmer permits the operator to record the positioning of both axes of the controlled machine simultaneously

Simplified Machine-Tool Control

A UNIQUE SYSTEM of programming which does not require the use of computer techniques and equipment for point-to-point or continuous-path positioning control of machine tools for both new and retrofit applications has been developed by Micro-Path, Inc., Inglewood, Calif., a subsidiary of Topp Industries, Inc.

Computer input is eliminated by the use of the record-playback principle, by which a controlled slide is moved through the motions desired on the recorded program, using the special controls provided. Tape preparation can be carried out by draftsmen or skilled machine operators rather than through the use of specially trained computer-programming technicians.

Using the stylus programmer, parts can be produced directly from dimensions on rough engineering sketches, finished blueprints, precision-scribed layouts, simple sheet-metal templates, or actual parts. The prints or templates can be full size or 4:1, and the use of the larger ones will reduce recording errors to one quarter.

Further, it is not necessary to calculate cutter offset during programming, as the use of a stylus end—to be explained—which has the same diameter as the cutter, automatically compensates for this factor.

Controls are also provided to permit the operator to set up an automatic backlash elimination at each point of slide reversal. Since the backlash-elimination control is completely independent of the magnetic-tape program, duplicate tapes may be used with many different machines.

Programming can be accomplished in one or two of three axes by the use of a stylus programmer with automatic programmed selection of which two of the three axes are under tape control. Simultaneous three-axis control can also be supplied at extra cost. Slight pressure on the stylus causes the controlled slide to move in the direction desired. The Micro-Path stylus control is a direction and pressure-sensitive device, and the entire range of feeds is controlled from within a stylus deflection of 0.001 in. In response to pressure variations applied to the stylus control, an electronic system generates pulses which move the table accordingly, and at the same time records the pulses in the proper channel of the magnetic tape.

The recording medium is an 11-channel $^3/_4$-in-wide magnetic tape on which eight channels are used to store the motion information in each direction for each axis. Two of the remaining three channels control internal and external auxiliary functions, and the other executes the commands for the auxiliary functions. Simultaneous three-axis systems require 1-in-wide tape.

In actual programming, the operator sets the controlled slides to a reference point with the recording controls inoperative. Once at the reference point, the accumulating position indicator and dial indicator for each axis are set to zero. Then, after switching to record, the operator need only manipulate the positional control, or the stylus control, causing each slide to move in the desired direction and at the desired feed rate until the required dimension is indicated in the dial indicator.

As the electronic system generates pulses to move the slide according to the operator's setting of positional control, or the stylus programmer, pulses are also recorded in the proper channels of the magnetic tape. By manipulation of the control, both rapid advance and slow approach can be programmed into the recording.

Once at the desired position, the operator can program in all auxiliary functions necessary to complete the machining operation; such as spindle start, quill down, coolant on, or other similar instructions. This process is repeated for each successive point in the program.

Several machine-control units are manufactured as modular components to provide the potential user of the Micro-Path system with considerable flexibility in the application of the units to his manufacturing requirements. A Pulservo Power Unit is a unique pulse-operated servomotor which is controlled directly by the pulses read from the magnetic tape. One is required for each motion to be controlled, and the output may be translated to any desired feed rate and positive-accuracy resolution at the driven shaft through selection of appropriate reduction ratios.

A self-contained two-axis contour table is designed specifically for continuous-path milling controlled from magnetic tape, and has built-in Pulservos and precision ball lead screws for each axis. It can also be used for programming.

A 4 × 7-ft, 3-ft-high programming table is also available for stylus programming of large parts. This unit may be used in the drafting room. The scale factors provided are: 40:1, 20:1, 10:1, 8:1, 5:1, 4:1, 2:1, and 1:1. The Micro-Path Programming Table is provided with two Pulservo motors and *x*, *y*, and *z* numerical position indicators.

A 3-axis, $^1/_4$-hp Micro-Path installation including Contour Recording Stylus will sell for $21,900, plus approximately $1000 for fitting. A 3-axis, 2-hp Micro-Path conversion will sell for approximately $24,000, plus a fitting charge depending on the type of machine tool.

Typical examples of feed rate and electrical accuracy, according to the company, are: 100 in. per min, ± 0.0005 in.; 50 in. per min, ± 0.0002 in.; 15 in. per min, ± 50 microin.

Unique Turbine and Controls

An unusual new turbine and an intricate control setup designed and built by De Laval Steam Turbine Company, Trenton, N. J., provide efficient, economical power for a new pulp mill where wide shifts in steam and electrical demand would periodically send gages spinning.

Short on available power sources, Thurso Pulp and Paper Company, Thurso, Que., Canada, planned a turbogenerator set for its new 200-ton-per-day bleached-kraft pulp mill. Major design conditions included: (*a*) Wide shifts in electrical load from weekday to weekend, summer to winter, varying in a ratio of 10 to 1; and (*b*) periodic, instantaneous drawdowns of 60,000 to 100,000 lb per hr from a total steam capacity of 300,000 lb per hr for process use.

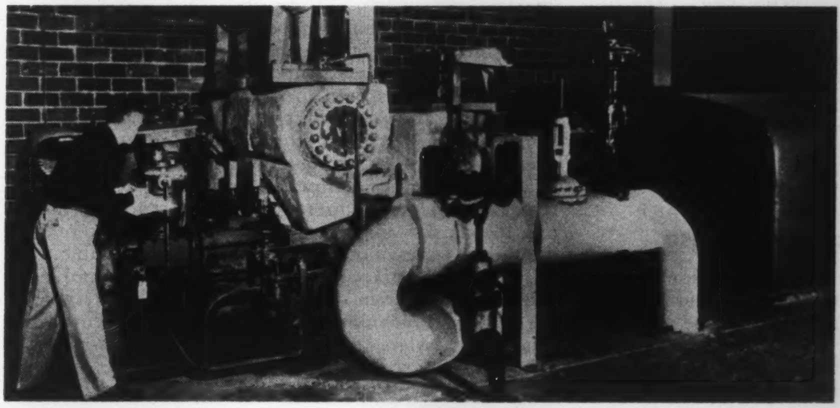
Unique feature of the De Laval turbine is its restricted exhaust end designed for a generator load of 2000 kw instead of 7500 kw rated full load. The turbine has two extraction points—one uncontrolled at a rated 135 psig, the other controlled at 40 psig. With the 135-lb opening closed and the 2400/4160-volt generator operating at full load, maximum controlled extraction at 40 lb is 170,000 lb per hr. When uncontrolled 135-lb extraction reaches its rated maximum of 36,000 lb per hr, controlled extraction drops to 135,000 lb per hr for a 6700-kw load.

A 200,000-lb-per-hr power boiler in parallel with a 100,000-lb-per-hr recovery boiler supplies steam at 450 psig, 710-F throttle temperature. These boilers supply not only the turbine but also the paper machine, sawmill, 125 and 40-lb reducing stations, and boiler auxiliaries.

Full drawdown by the pulp-mill digesters creates such an excessive demand for steam at the uncontrolled extraction point that the turbine would not be able to carry full electrical load. To prevent this from happening, a pneumatic position transmitter linked to two servomotors signals the pressure-reducing station in the line from the 135-lb extraction point to throttle and close this valve.

Steam for evaporators of the pulp mill, bleach plant, heating system, and sawmill is drawn from the 40-lb turbine extraction point which is also connected by a header to the paper machine drive-exhaust and pressure-reducing-station discharge.

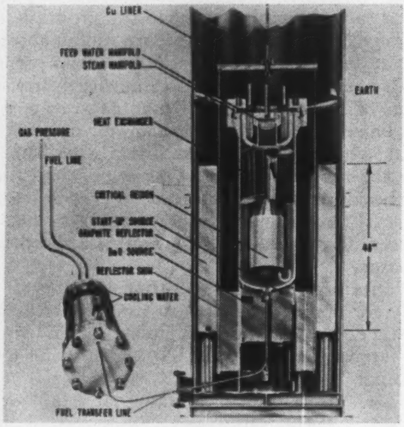
Efficient steam consumption under low-load conditions such as during a summer weekend, dictated use of the restricted exhaust end, whose minimum size agrees with a maximum expected straight-condensing load. The shift from reduced weekend to normal weekday loads presents unique control problems because of the intricate linking of the turbine with the process-steam service for the plant. The extraction-regulator control system designed by De Laval, however, provides both accurate response for good steady-state conditions and instantaneous response for rapid fluctuations.



Wide variations between electric load and process-steam requirements required an unusual new turbine and intricate control system for installation in a pulp mill

Gold plating is used to reduce corrosion on the fuel-solution side of the heat exchanger for the LAPRE-II

The heat exchanger is in the same pressure vessel as the reacting fluid. Natural circulation carries the heat to the exchanger.



Homogeneous Power Reactor

A unique homogeneous power reactor experiment designed to produce superheated steam in one simple operation is being tested in the Atomic Energy Commission's Los Alamos (N. Mex.) Scientific Laboratory, operated by the University of California.

The purpose of the Los Alamos Power Reactor Experiment No. 2, LAPRE II, is to determine the feasibility of a reactor concept using a solution of enriched uranium phosphate, phosphoric acid, and water as fuel. Natural circulation of the solution is relied upon to carry the heat to the heat exchanger where high-pressure superheated steam is produced. The reactor is expected to generate 1000 tkw.

The heat exchanger for steam generation in the reactor is enclosed in the same pressure vessel as the reacting fluid. Because the fluid is extremely corrosive, gold cladding protects the structural metals which are in contact with the solution. The cylindrical gold-lined stainless-steel pressure vessel is about 4 ft tall and has an ID of 15 in.

Criticality is achieved simply by inserting the liquid fuel in the reactor core. As the fuel temperature rises from 70 to 800 F because of the nuclear reaction, the fuel expands 15 per cent.

This expansion forces the uranium atoms apart which reduces reactivity until a stable temperature is achieved. When cold water is forced through the heat-exchanger coils, heat is withdrawn from the fuel closest to the coils. This heat withdrawal causes the fuel to contract, drawing the atoms together, increasing reactivity, and automatically compensating for heat loss. The fuel temperature remains essentially the same whether or not the heat exchanger is being used to generate steam.

Standards-Laboratories Assistance

Opportunities to advise in the establishment and operation of standards laboratories for both industry and military agencies are being welcomed by the National Bureau of Standards as part of its own primary duty to provide basic standards to science and industry. Ordinarily no charge will be made for any assistance the NBS can reasonably render within the limitations of its staff and facilities.

Such laboratories can absorb a major part of the testing and calibration work load, permitting the NBS to concentrate more of its resources on the development of new or improved standards, test methods, and precision techniques to keep up with the needs of advanced technical research. Calibration work can be increasingly restricted to the comparison of master or reference standards of other laboratories with the national standards.

Summary technical report no. 2324, February, 1959, outlines the steps and lists the NBS publications that may be helpful to other laboratories in approaching the Bureau for information or assistance.

Coal-Fired Gas Turbine

The work of the Locomotive Development Committee, LDC, of Bituminous Coal Research, Inc., has been terminated with the announcement that the Union Pacific Railroad will build a commercial-model coal-fired gas-turbine locomotive incorporating the design features developed by LDC research.

A 4200-hp turbine, valued at $1.2 million, has resulted from 12 years of intensive industrial research, and has operated more than 5000 hr since 1950. The specially designed combustion chamber of the turbine is of the film-cooled jet-airplane type. Combustion efficiency is 97 per cent at elevated temperatures and pressures.

The turbine has been loaned to the Bureau of Mines for a co-operative research program with industry at the Bureau's Appalachian Experiment Station, Morgantown, W. Va., that will determine the changes needed to qualify this type of equipment for use in stationary electric-power plants. Unrestricted by the space limitations of a locomotive chassis, plant-design changes to provide durability and economy are expected to be possible.

This type of plant would be particularly suitable for generating power in the arid regions of the West, since the coal-fired turbine requires no water. Improved turbine-blade design and improved construction materials will be sought to fulfill the long life requirements of stationary plants. Even better fly-ash control than the dust-collection efficiencies in excess of 92 per cent achieved by LDC will be another objective.

Approximately $\$5^{1}/_{2}$ million have been spent since 1945 by coal companies and railroads sponsoring the LDC program. Present sponsors include six railroads: B & O, C & O, Illinois Central, Louisville & Nashville, Norfolk & Western, and the Virginian Railroad Company; and four coal companies: Consolidation, Island Creek, M. A. Hanna, and Pocahontas Fuel.

More than 100 patents issued, and approximately 25 still pending are being made available to the Bureau of Mines.

Fully Automated Power Plant

A FULLY automated 225,000-kw electrical power-generating station will be constructed at Little Gypsy, La., for Louisiana Power and Light Company.

All phases of Little Gypsy's operation—from start-up through operation to shutdown—will be controlled automatically by a special electronic-computer system designed and built by Daystrom Systems, La Jolla, Calif., a division of Daystrom, Inc.

A total of 800 different "steps" are involved in start-up or shutdown and the computer will be able to complete start-up in $4^{1}/_{2}$ hr compared with 6 hr for a manual start.

The computer system is of the "solid-state" type with a total of 4000 transistors and more than 7000 diodes. For maximum operating life, there are no moving parts anywhere in the entire computer control system. Daystrom has guaranteed 99 per cent availability—24 hr a day, 365 days per yr.

Little Gypsy will be staffed by the normal complement of three human operators for safety and maintenance. The real advantage of automation is faster reaction and greater sensitivity. Because of this, the station can be operated much closer to actual equipment operating limits for highest over-all efficiency and—most importantly—with unprecedented safety.

In addition to continuously monitoring all phases of the station's operation, the computer will examine itself every two minutes. If the computer finds itself "confused," it will "resign," and turn over the operation of the plant to the human operators.

The new control benefits from experience gained at Louisiana Power and Light Company's Sterlington Station, where a Daystrom solid-state operational information system containing some 4000 transistors and 7000 diodes has been in successful service without a single component failure for almost one year.

A digital computer with adequate memory is ideally suited to the extensive and detailed decisions involved in the preparation of the programmed steps which comprise start-up or shutdown.

It will be possible to instruct the computer to turn back or skip ahead to any other operational step. The system will monitor a large number of selected input signals continuously, and formulate alternative routes which could not be found when using only conventional mechanical timers, sequential cams, and sensing relays.

When the computer puts the station on the line it automatically reprograms itself and goes into operational mode. It runs the plant, operating these major control loops: (a) Combustion control, (b) steam-temperature control, (c) feedwater control, (d) spray control (overriding steam-temperature control—a safety feature).

The installation includes a fuel-safety and purge system. Upon any indication of an explosive mixture in the boiler, gas is shut off instantaneously and the boiler is purged with air. Necessary shutdown procedures are instigated immediately.

During normal operation the computer checks itself during every scan cycle (every two minutes). All inputs are scanned for over or underlimit operation. If these cannot be corrected by the system, visual and audible alarms and special print-out tell the operator exactly which point is off limits and how far.

The computer is in continual contact via microwave link with the main LP & L dispatching station in Pine Bluff, Ark., which tells the computer directly to increase or decrease station output. Within one second of a command, proper action is taken simultaneously on all operating loops.

The computer constantly monitors the phase of the system and the generating unit. Should malfunction occur and the generator get out of phase, the computer immediately removes it from the line. (It would take 11 to 15 sec for a good human operator to find out what was wrong—before he even started to take action.)

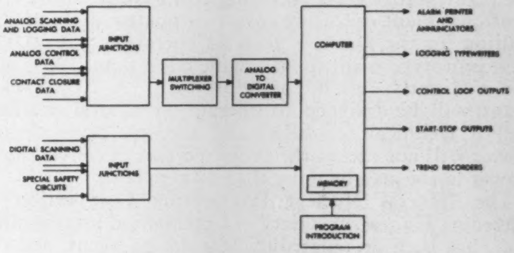
The computer system will be programmed to print out proper station log sheets once each hour on the hour. Provisions exist, however, at the discretion of the human operator, to print out log data with each complete scan cycle or any multiple thereof.

Special display of plant efficiency is also provided by the computer, which compares Btu input with kw output.

To monitor the plant equipment for safe operation, the computer system selects each input variable in accordance with the requirements set forth in the computer program, and accepts the basic measured information in digital form from an analog-to-digital converter. All computations (linearization, square-root extraction, zero offset, scale factoring, and reference-junction compensation) are performed in the central computing equipment. The scanning operation may not necessarily follow an orderly sequence. Since the computer addresses each input, the instructions stored in the memory may incorporate special alterations in the scanning sequence.

Little Gypsy, for fully automatic operation, will cost only 2.5 per cent more than it would have for semiautomatic operation. Steam conditions will be 2000 psig and 1000 F with reheat at 1000 F. Initial fuel will be gas with provision for solid fuel.

Design and construction are by Ebasco Services Incorporated. The boiler is to be provided by the Riley Stoker Corporation of Worcester, Mass., and the turbine-generator unit by the General Electric Company.



Simplified diagram for the computer control system of the Little Gypsy fully automated power plant

Industrial Nuclear-Radiation Studies

The behavior of equipment under moderate or low radiation doses over long periods of time—on which there is little information—will be investigated by General Electric in the largest cobalt-60 facility yet constructed for this type of work.

The $1.5-million facility at the company's General Engineering Laboratories, Schenectady, N. Y., was built without government subsidy. It is a 22 × 12 × 10-ft room with 4½-ft-thick walls. A 10,000-curie (later to be increased to 15,000) radiation source contained in a metal basket is drawn up from beneath 16 ft of superpurified water in a storage well below the room. A water-filled window and closed-circuit television provide visual observation.

In contrast to conventional procedures where equipment is generally tested piece by piece, complete motors and transformers, for example, will be radiation tested while in actual operation. This can be done at intensities up to 500,000 roentgen per hr. By contrast, 0.007 roentgen per hr is the most a human being can stand.

Two 1-Mev particle accelerators—one providing low-penetration electrons, the other high-penetration neutrons—are provided. Not only machinery, but a wide variety of equipment and materials—solid, liquid, and gaseous—will be radiation tested. This will be a continuation of studies which led to the development of a new type of electrical insulation, first industrial product of nuclear bombardment, three years ago.

Gas-Cooled Pressure-Tube Reactor

The AEC has signed a contract with East Central Nuclear Group, Inc., and the Florida West Coast Nuclear Group (see MECHANICAL ENGINEERING, November, 1959, p. 98 for member companies) for research and development work on a gas-cooled nuclear-power plant of advanced design. The Plant will be constructed in the Florida West Coast area, under the AEC's Power Demonstration Reactor Program.

East Central Nuclear Group, Inc., will conduct the research program to develp a heavy-water moderated, gas-cooled, pressure-tube reactor of advanced design. The cost of this research program, presently estimated to be about $18 million will be shared approximately equally by East Central Nuclear Group, Inc., and the AEC. The contract makes provision for additional research and development work if required.

The Florida West Coast Nuclear Group will assume construction costs of about $26 million and will operate the plant, with excess operating costs—those above conventional plant-operating costs—estimated at about $5.4 million for the first five years of operation. A 50,000-ekw prototype plant to be completed in June, 1963, will use a slightly enriched uranium fuel. A 200,000-ekw plant will be designed to operate on natural uranium fuel if technical feasibility and the cost of producing power will not exceed the projected cost of conventional power in the area by more than 50 per cent.

The General Nuclear Engineering Corporation of Dunedin, Fla., a subsidiary of Combustion Engineering, Inc., has been designated nuclear design agent, and the American Electric Power Service Corporation is expected to be the principal design and construction engineer for the project.

Nuclear Briefs

▶ Factory Shipments of Atomic-Energy Products

1957 FACTORY shipments of certain key atomic-energy products produced in privately owned plants amounted to about $100 million, according to preliminary results of the first annual joint survey by the Bureau of the Census, Department of Commerce, and the Atomic Energy Commission.

Almost 200 companies had some shipments of the products listed. A large number of firms reported that while they had no shipments to report for 1957, they would be listed in the 1958 report.

Shipments of radiation-detection and monitoring devices amounted to more than $16 million and shipments of reactor vessels and tanks totaled more than $10 million. Other large categories in terms of dollars were: Accessory instrumentation for reactor control—$9.5 million; complete fuel elements—$8.6 million; valves, pumps, and heat exchangers uniquely for nuclear uses—$7.8, $6.1, and $8.3 million, respectively; control and measuring devices containing isotopes—$6.0 million; reactors (those completely assembled at place of manufacture)—$5.7 million; and other specialized reactor components—$4.5 million. Other categories covered in the survey included hot-laboratory equipment, partially completed fuel elements, natural and enriched uranium metal and compounds, and reactor control-rod drive mechanisms.

This survey, although the most extensive made thus far on private-industry participation in the atomic energy field, does not cover the entire field. Excluded are construction expenditures, engineering and design costs, research and development expenditures, except for the products listed, as well as products and materials used in atomic-energy work which are not specifically designed for nuclear use. For some reactors, the items not included in the survey have contributed from 70 to 80 per cent of the total reactor cost.

▶ Internal Nuclear Superheater

Allis-Chalmers has received AEC approval of a research and development project for an internal nuclear superheater in the Pathfinder plant nuclear reactor. A-C is prime contractor for the 66-emw plant to be built for Northern States Power Company, near Sioux Falls, S. D.

Use of a nuclear superheater, incorporating new engineering concepts, will represent another major advance in atomic-power technology. The nuclear reactor, with the superheater in its core, will function as a single boiler.

The controlled-recirculation boiling reactor with nuclear superheater will be of the heterogeneous type with light water serving as coolant and moderator. Total plant heat output will be about 203 mw with the turbine-generator producing 66 emw gross. Net power will be 62 mw, resulting in an over-all expected net plant efficiency of 30.5 per cent.

The boiler will be fueled with low-enrichment uranium and the superheater with high enrichment fuel.

Present research and development plans include continuous research projects for a suitable low-enrichment fuel for the superheater.

Turbine and auxiliaries for the Pathfinder station are of conventional design.

The reactor vessel for the Dresden Nuclear Power Station has been delivered to the site in Illinois

Dresden Reactor Delivered

The nuclear reactor for Commonwealth Edison's 180,000-kw boiling-water Dresden Nuclear Power Station near Morris, Ill., has been delivered.

The reactor completed the 3600-mile water trip from the Camden, N. J., plant of New York Shipbuilding Corporation in 24 days. It was towed down the Atlantic east coast, across Florida, up the Gulf and the Intracoastal Waterway to New Orleans. Then it was taken up the Mississippi and Illinois Rivers to the site.

After pulling out of the Dresden lock in the Illinois waterway it was towed to the unloading dock on the adjoining Dresden property. The reactor was then "house-moved" on its structural steel frame the third of a mile to the 180-ft steel sphere in which it is to be installed.

British A-Sub to Have *Skipjack* Drive

A complete set of *Skipjack*-class nuclear propulsion machinery will be furnished by Westinghouse for the *Dreadnought*, the first British atomic submarine. Full exchange of design, manufacturing, and operating data from Westinghouse and Electric Boat (the builders of the *Skipjack*) is provided in the contract, with the right of future manufacture in Great Britain for a shore-based prototype at Dounreay.

A statement made in the House of Commons on behalf of the First Lord of the Admiralty indicated that: "The successful conclusion of these complex negotiations is due to the close collaboration which exists between the parties mainly concerned—the firms, the U. S. Navy, the U. S. AEC, the Admiralty, and the AEA."

Isotopic Age Determination for Materials

An isotopic dating method will be developed by The Goodyear Tire & Rubber Company under a $50,000 AEC research and development contract. An isotopic dating method has wide potential for determining the length of storage and service of many supplies, particularly those in military use. Airplane tires, for example, have limited storage and service lives.

In the general area of protective or preventive maintenance, where replacement could be made before failure, the average age of articles in actual service could be determined easily, particularly where code numbers and other markings wear away in service. By measuring the amount of radiation from known radioactive materials, it is possible to compute the age of an item in which the materials are present. Recent development of ultrasensitive low-level counting devices makes it possible to monitor extremely low amounts of radiation well within safe-exposure limits.

330,000-Kw Pressurized-Water Plant

Nuclear power at costs competitive with fossil fuels in the higher-fuel-cost areas of the United States should be possible with a 330,000-kw advanced pressurized-water design which Westinghouse Electric Corporation is "prepared to develop, design, and manufacture."

The pressurized-water design is proposed because this would be the fourth generation of this type of reactor.

Other types which Westinghouse now has under development are: (*a*) A 17,000-kw prototype pressure-tube reactor to be built by the Carolinas-Virginia Nuclear Power Associates at Parr, N. C.; (*b*) studies for a 50,000-kw organic-moderated fluidized-bed reactor for the City of Burlington, Vt.; (*c*) an integral-boiling superheat reactor—"the most advanced of the water systems"—with steam temperatures equal to those of conventional plants, is ready for the prototype stage; (*d*) the nuclear-thermoelectric plant—"still very much in the future"—would combine nuclear energy and direct conversion of heat to electricity; (*e*) the homogeneous reactor—recently dropped—"has a most promising future," according to Charles H. Weaver, Mem. ASME, and vice-president in charge of atomic power. "Just where this reactor fits in the time scale of nuclear-power development is not immediately clear," he states. "When it is appropriate to once again proceed with a substantial development effort, Pennsylvania Power and Light and Westinghouse believe that a prototype plant is next."

Hallam Nuclear Power Facility

The AEC has selected Peter Kiewit Sons Company of Omaha as general contractor for construction of the nuclear portion of the Hallam Nuclear Power Facility at Hallam, Nebr.

The 75,000-ekw-net facility, which will be constructed under a co-operative arrangement between the AEC and Consumers Public Power District of Nebraska, will include a sodium-cooled, graphite-moderated reactor.

The nuclear power plant will be operated by Consumers as part of its electrical generating system. Atomics International, a division of North American Aviation, Inc., of Los Angeles, Calif., is responsible for nuclear design and procurement of major reactor components. The architect engineer for the nuclear plant is the Bechtel Corporation of San Francisco, Calif.

The objective is to produce at least 710,000 lb of steam per hr at the turbine throttle for the electrical generating facility.

The plant design is largely derived from the Sodium Reactor Experiment operating at Santa Susana, Calif.

Cost of the reactor portion is estimated to be about $29 million, of which Consumers is providing $5.2 million. In addition, Consumers is providing the site and the turbogenerator. ●

PHOTO BRIEFS

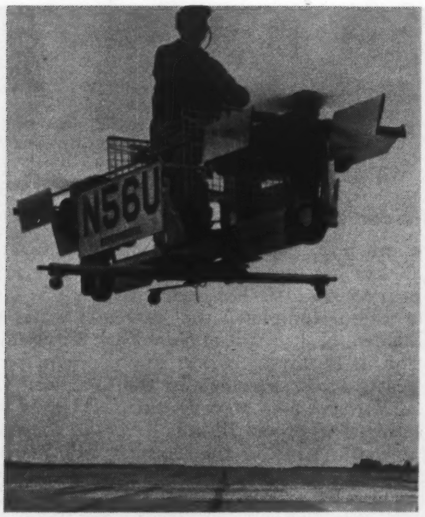
1 Low-Cost VTOL. Igor Bensen, Mem. ASME, pilots a single-seater, twin-engine, tandem "prop-copter" which Bensen Aircraft Corporation, Raleigh, N. C., is developing as a low-cost vertical-take-off-and-landing craft.

2 Tantalum Bayonet Heaters. A heat-transfer rate seven to eight times greater than that for units of conventional materials is claimed for tantalum bayonet heaters manufactured by the Pfaudler Company. For use in acid condensers and other process equipment, they also possess excellent resistance to physical and thermal shock.

3 Stationary-Field Magnetic Clutch. More torque for the same size is provided in stationary-field magnetic clutches made by I-T-E Circuit Breaker Company, Philadelphia, Pa. Hence machine-tool transmissions can be smaller. The problems created by slip rings and brushes on conventional clutches are eliminated by converting part of the roller-bearing thrust load to bear against the radial needle bearing.

4 EBR-II Condenser. A 16,000-sq-ft, two-pass, divided-water-box condenser made by Allis-Chalmers will be installed to serve the 20-mw turbine-generator in the Experimental Breeder Reactor II, near Scoville, Idaho. Two condensate pumps, one motor-driven and one turbine-driven, each rated 530 gpm at 550 ft TDH, accompany the condenser.

5 Recording Pyrometer. Surface changes in temperature over a 3/8-in-diam area are accurately measured in the 1400 to 3000-C range by the Auto-Optic recording pyrometer announced by Avco Research and Advanced Development Division, Wilmington, Mass. Response time is in milliseconds and operation is unattended when conditions are hazardous.



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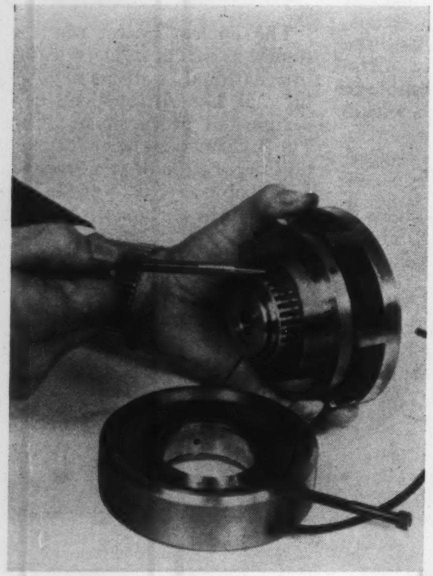

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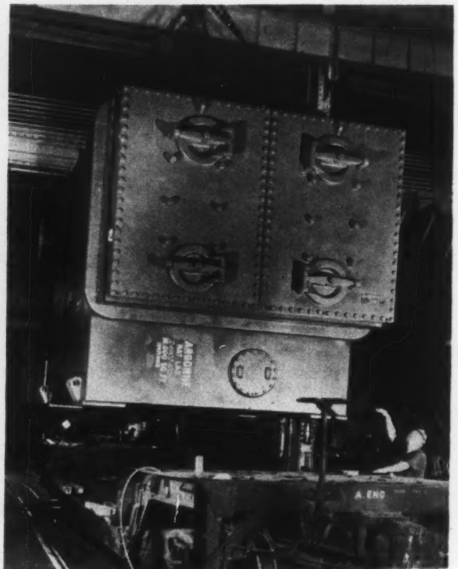

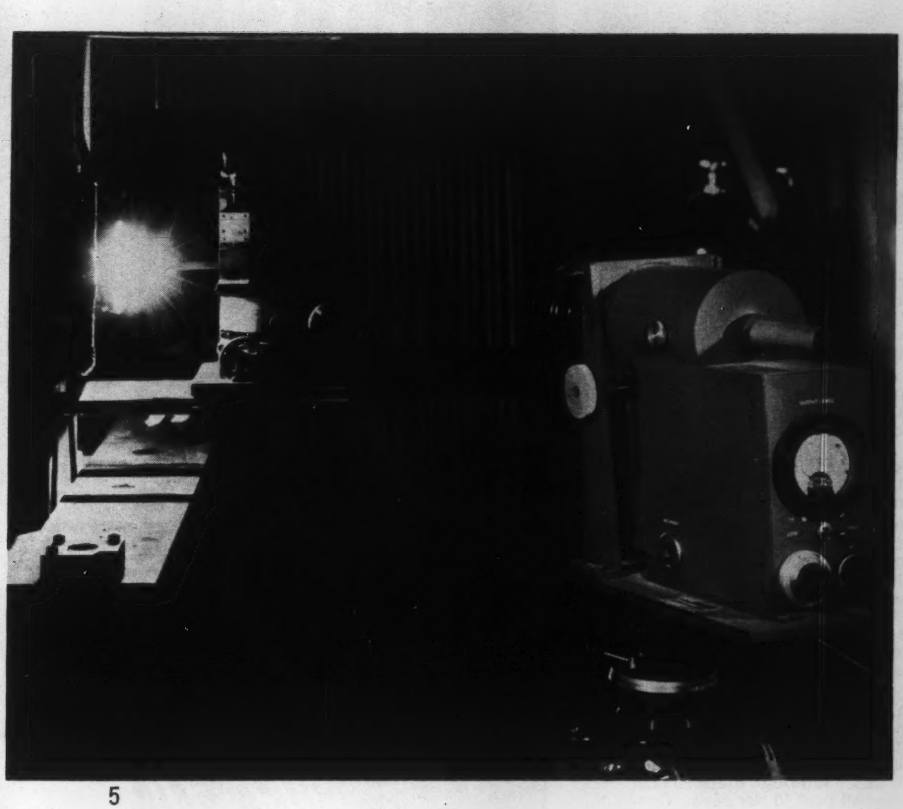

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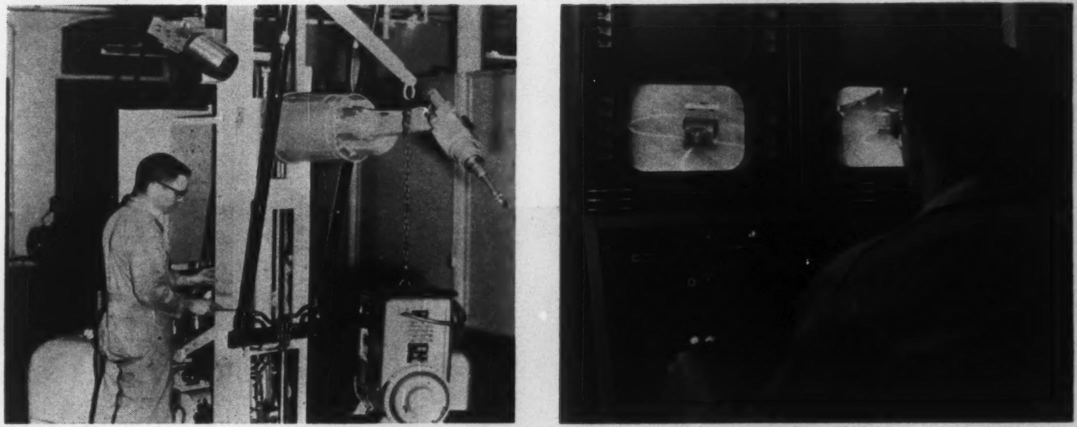

6a

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6 Remote-Handling Equipment. Largest of six units remotely controlled by radio for handling radioactive material is a 3-ton, 8-ft-high, fork-lift truck, a, equipped with three versatile arms. One can perform human wrist and arm functions, and the others lift a small wrench or 1000-lb object up to 15 ft. Other equipment cuts pipe or performs welds. Specially trained technicans monitor the remote-maintenance force with television receivers, b. Units were developed by the Babcock & Wilcox Company's Atomic Energy division and the B & W Research and Development Center.

PHOTO BRIEFS

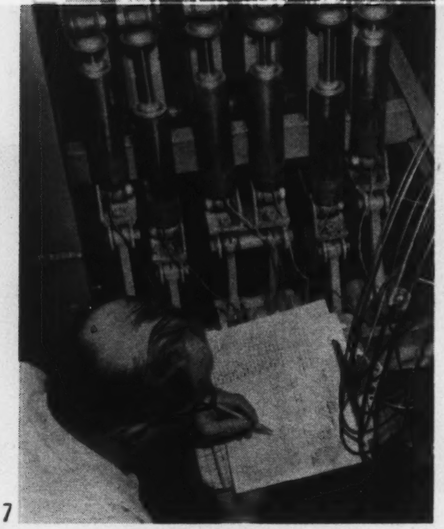
7 Mandrel-Drawn Shock-Absorber Tubing. Jones & Laughlin produces 2 million ft a month of mandrel-drawn tubing with unusually smooth ID's for the Gabriel Company of Cleveland, Ohio. Used for the inner cylinders of shock absorbers, it is produced with close tolerances at a cost 400 to 500 per cent below that of honed tubing.

8 Transistor Sorter Detects 1200 Performance Levels. Hand testing and sorting of transistors as small and as similar as grains of rice are eliminated at Raytheon Manufacturing Company with an automatic tester-sorter. The operator places a transistor in a test socket, presses a starting button, and the machine hunts through a series of qualification levels. From the test socket the transistor is slotted into the proper one of 1200 bins.

9 Continuous Casting of Aluminum. A modest capital investment permits strip customers to do their own melting, casting, and rolling of aluminum and aluminum-alloy strip in one integrated operation with a continuous-casting machine made by Lobeck Casting Processes, Inc. A 5-ft-diam wheel has trough-shaped grooves which determine depth and width of the slab to be cast. The groove is closed for casting purposes by an endless steel belt running along part of the casting-wheel circumference and over three guide sheaves. Wheel and belt are water-cooled to produce a sound metallurgical structure.

10 Modular Concrete Construction. Tongue-and-groove precast concrete slabs slip into slotted-concrete-block corner, center, or partitioning columns in a system patented by Shaffer Block Works, Somerset, Pa. Strength is superior, and insulating properties equivalent, to a 10-in. concrete-block wall. Although material cost is the same, labor savings reduce over-all cost 10 per cent. Concrete-block pilasters are set on 12-ft centers and mounted on 24-in-sq footers.

11 Double-Bed Lathe. A 45-ft-long × 105-in-diam workpiece can be handled by a 75-ton double-bed lathe made by R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. Spindle bearings will take a 50,000-lb line load. Speeds range from 1 to 110 rpm with feeds as low as 0.01 in. per revolution. Intended for large but light workpieces it is equipped with a variable-speed motor of only 50 hp. Two or more carriages can be operated on the forward ways.



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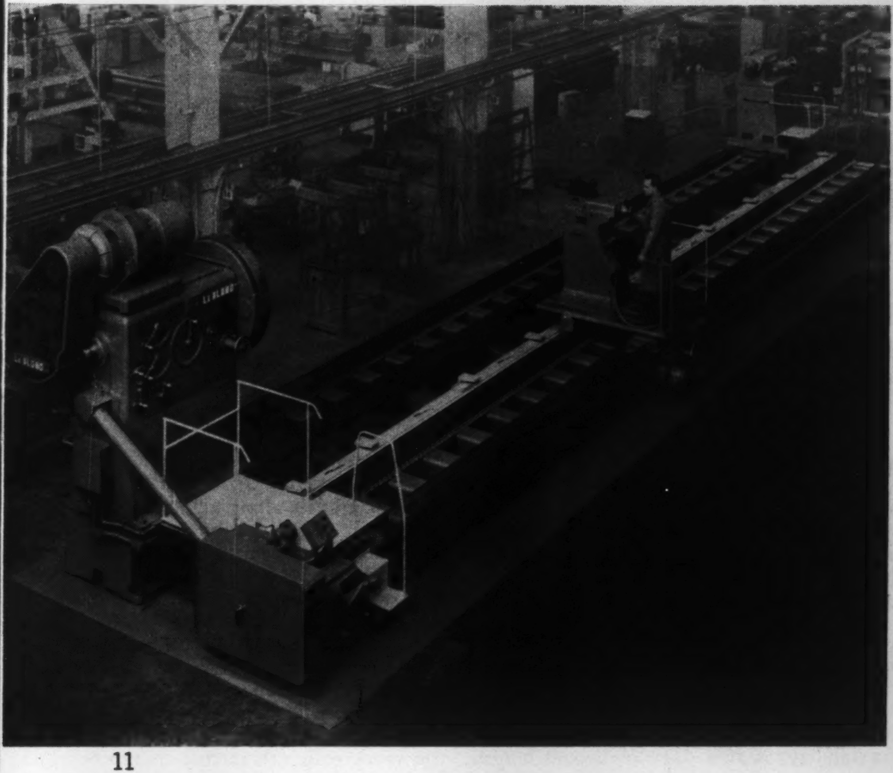

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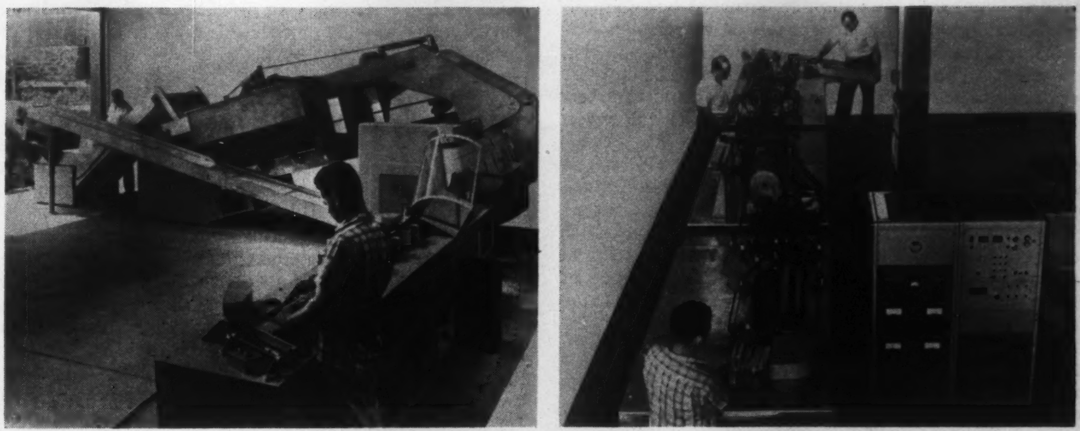


12a

12b

12 **Automatic Mail-Handling Equipment.** A culling machine, **a**, separates ordinary-size letters from bulk mail by diverting parcels, thick envelopes, and tied bundles of letters to side bins as the bulk traverses a series of inclined conveyer belts. The facing machine, **b**, scans individual letters photoelectrically to locate the stamps or reject those without stamps. A properly positioned letter with stamp goes directly to the canceling station. An inverting mechanism correctly orients others. The equipment, designed and built by American Machine & Foundry Company, is installed in the main Post Office in Washington, D. C., for testing.

Engineering
Progress in the
British Isles and
Western Europe

J. FOSTER PETREE
European
Correspondent

EUROPEAN SURVEY

8000 Tons per Week Hot Strip Mill

A HOT strip mill to produce strip from 18 in. down to 4 in. wide, in thicknesses from $^1/_4$ in. down to 0.06 in. in the greatest widths and 0.042 in. in the smallest, has been installed near Sheffield, England, by Steel, Peech & Tozer, Ltd., one of the firms in the United Steel Companies group. It is contained in a building 800 ft long and 305 ft wide, consisting of four bays.

In the first bay are the roll shop, motor house, and repair shop, served by overhead traveling cranes of 10 tons and 7 tons capacity. The adjoining mill bay is 56 ft wide with two overhead cranes, of 25 tons and 10 tons, respectively. Next comes the slab bay, 96 ft wide, with three 15-ton cranes; and finally, there is the coil bay with three 10-ton cranes of 106 ft 6 in. span.

The steel is received by rail from another works of the group in the form of slabs 28 ft 6 in. long, 18 in. wide, and 3 in. thick, weighing rather more than $2^1/_4$ tons each. These are examined in the slab bay, any surface defects being removed by oxygen burners, and are transported by crane to a depiler, situated between the two oil-fired heating furnaces, each of which can deal with 75 tons per hr. The hearths are 60 ft long × 31 ft 6 in. wide. The furnaces are fitted with Schack recuperators for heating the combustion air and each has its own cold air fan (22,000 cu ft per min) and waste gas fan (70,000 cu ft per min). The slabs are pushed through the successive heating zones by electrically operated pushers, the temperature, atmosphere, and pressure in each zone being under automatic control. They are delivered to a live roller table 135 ft long which takes them to the first section of the mill, consisting of a horizontal edging and scale-breaking stand, driven by a 350-hp a-c motor through a flywheel-assisted reduction gear.

The roughing train comprises four two-high mills with rolls 21-in. diam and 24-in. barrel length. Immediately in advance of the third mill there is a 26-in. vertical edging stand. No. 1 stand is driven by a 700-hp a-c motor through a flywheel-assisted reduction gear; Nos. 2 and 3 stands by a-c synchronous motors of 1200 hp; and No. 4 stand by a 1200-hp d-c motor. All stands have totally enclosed water-lubricated fabric bearings, and a centralized oil lubrication system supplies the gearbox and pinions of the roughing train. From the roughing mill the stock travels along a 150 ft delay table to a rotary flying shear, which can be used either for end trimming or for emergency shearing. The shear is driven by a 300-hp d-c motor and can cut hot strip up to 1 in. thick and 18 in. wide, traveling at speeds up to 450 fpm.

The finishing train has six four-high rolling-mill stands and two vertical edgers, one in front of No. 1 stand and the other between Nos. 2 and 3. Each edger has a 75-hp motor. The finishing stands have 14-in-diam work rolls and 23-in-diam backup rolls, all of 23-in. barrel length; the work rolls are carried in taper-roller bearings and the backup rolls in multiroller cylindrical bearings, all lubricated by an automatic pumping system. The screwdown gear is electric. The drive to the rolls is by d-c motors, of 1200 hp for Nos. 1 and 6 stands and 1750 hp for the other four. When the strip reaches the last finishing stand it is traveling at up to 3000 fpm, and is delivered to a 160-ft cooling table, fitted with water sprays for use if required. Finally, the strip is coiled in one of two 20-in-diam horizontal downcoilers, each operated by a 175-hp d-c motor, the completed coils being ejected on to a conveyer for transference to the coil storage and dispatch bay. The conveyer runs at 30 fpm, can take coils up to 5600 lb in weight, and incorporates a 3-ton weighing machine. There are also two shearing lines, which can shear strip of the full width and thickness in lengths up to 30 ft; and, in another building, two pickling lines.

During rolling, continuous measurements are taken of the temperature, width, and thickness of the strip. Temperature is measured at four points and is shown on large circular indicators, clearly visible to the mill operators. Strip width is measured between the last finishing stand and the coilers by means of a photoelectric telescope above the cooling table, variations from the correct width being similarly indicated on large dials. Thickness is measured by noncontact means, a radioactive source being located beneath the strip and a detector above it; the intensity of radiation reaching the detector varies with strip thickness and is displayed pictorially on a lamp board in the motor room. A more permanent record is transmitted by teleprinter to the operator in the finishing mill pulpit. The cost of the new mill, which required heavy preliminary excavation work, was the equivalent of about $\$11^1/_2$ million.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Transportable Steam Power Unit

Though the use of the oil engine is now so widespread, there are still large areas in underdeveloped countries where the existence of locally produced fuels such as timber and agricultural wastes make the small steam engine an economic proposition. To meet the needs of such markets the firm of E. Reader & Sons, Ltd., of the Phoenix Engine Works, Cremorne Street, Nottingham, England, who specialize in the production of small steam engines, have designed a self-contained power unit consisting of a single-cylinder steam engine mounted on a common baseplate with a boiler of original type, capable of burning almost anything combustible and of being operated by unskilled labor with safety. The whole unit is so designed that it can be transported by native carriers, no single part weighing more than 120 lb and most being within the capacity of one man to lift and carry.

The boiler consists of a number of elements, each comprising a series of short straight tubes welded into headers. The tubes are arranged horizontally, and in each is a steel bar which fills the center of the tube, the water flowing in the annular space between the bar and the tube wall, thus insuring rapid heat transfer. By removing the plugs in the headers the bars can be readily withdrawn and the tube walls are easily accessible.

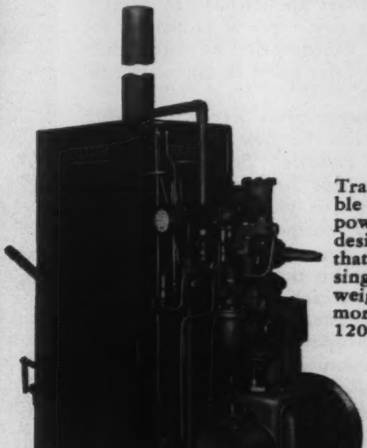
A shallow water tank is mounted on top of the boiler, serving to some extent as a feedwater heater, and from this the engine-driven feed pump draws its supply, the level being kept constant by a float value.

One engine has a bore of 4 in. and a stroke of 3 in., and is double-acting. It runs at 450 rpm to give the normal rated output of 5 to 6 hp, but can develop between 7 and 8 hp if pressed. Normally it is totally enclosed. The valve mechanism is arranged to allow an alteration in the direction of rotation. Lubrication is by splash. The flywheel incorporates a driving pulley and can be readily removed. The governor, at the other end of the engine, is totally enclosed. The piston-rod gland is self-adjusting and allows little water to drain into the crank-chamber; such water as does collect there is automatically drained off.

There are two engine-driven pumps, one for filling the water tank on top of the boiler and the other for feeding the steam generator. There is also a small hand feed-pump, used when starting the unit. While the engine is running it is impossible for the generator to run dry unless the pump suction is uncovered, and, should that happen, no serious damage results, as has been proved by repeated tests. For irrigation or similar pumping duties, the unit generates sufficient power to pump about 10,000 gal per hr; as a general-purpose power unit, it will drive a 16-in circular saw for a small workshop or provide a 3-kw electrical supply in addition to a pumping plant for hot or cold domestic services. ●

Finishing train of hot strip mill has six four-high rolling mill stands and two vertical edgers. When strip reaches finishing stand it is traveling at up to 3000 fpm and is delivered to the 160-ft cooling table.

Control pulpit for finishing mill. New mill cost about $\$11^{1}/_{2}$ million.



Transportable steam power unit is designed so that no single part weighs more than 120 lb

Substance in
Brief of Papers
Presented at
ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Gas Turbine Power

Operating Experience With Gas-Turbine Ships of the Maritime Administration..........59—GTP-16

By C. C. Tangerini and D. H. Specht, Office of Ship Construction, Maritime Administration, Washington, D. C. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

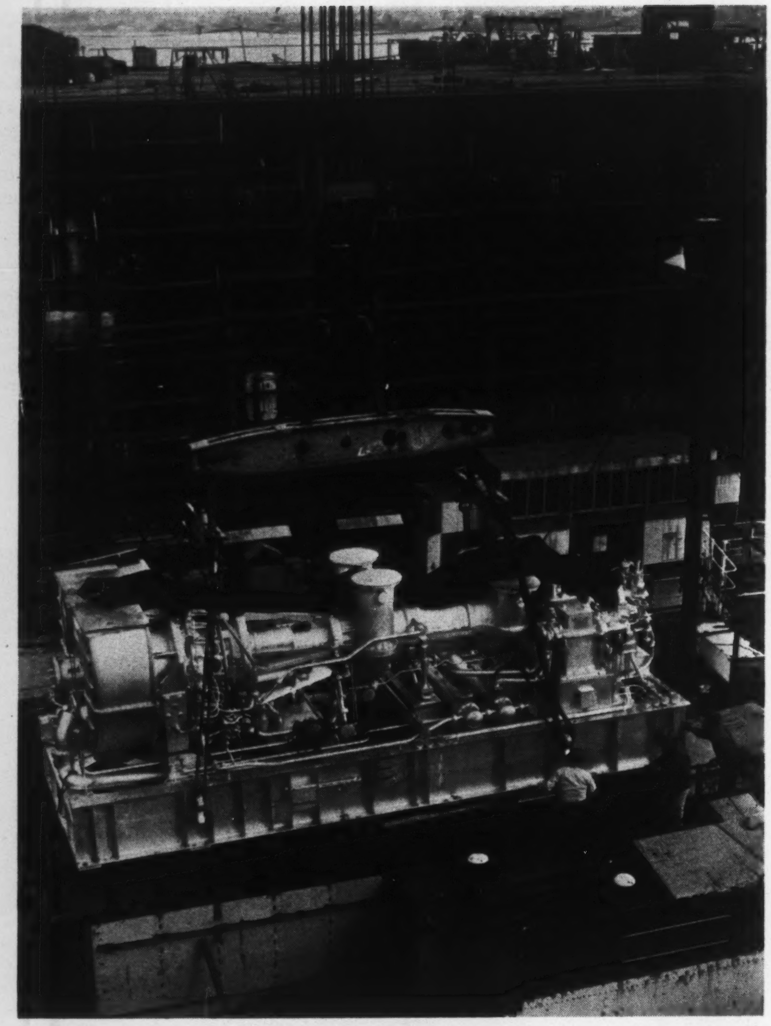
The experimental installations by the Maritime Administration of two types of marine gas-turbine prime movers, namely, the regenerative, open-cycle, gas-turbine plant in the converted Liberty ship, *John Sergeant*, and the free-piston, gasifier-gas turbine plant in the converted Liberty ship, *William Patterson*, have stimulated interest and discussion throughout the marine industry. These marine drives are intended to develop promising new types of propulsion for the U. S. merchant fleet by testing their potential value under actual commercial operation.

This paper gives service experience obtained on the *John Sergeant* and the *William Patterson*. Service experience with the *John Sergeant* covers approximately a two-year operating period since its completion in September, 1956.

During this time, the *Sergeant* sailed over 94,000 nautical miles with a total of 6567 operating hours on the open-cycle gas-turbine plant.

The information pertaining to the *William Patterson* deals with performance only. No attempt is made to include any details of construction of the main propulsion machinery other than those which have been modified or redesigned to correct deficiencies. The data presented must be considered preliminary and subject to change as additional operating hours on the vessel are obtained.

This is necessary since modifications and redesign of component parts and systems are continually being made as



Packaged assembly of *John Sergeant* consists of two-shaft, high-pressure and low-pressure turbine axially in line. The regenerative, open-cycle, gas-turbine plant has logged 6567 hr since 1956. (59—GTP-16)

more is learned about free-piston machinery.

The *Patterson* has sailed approximately 50,000 nautical miles during the 14-month operating period since its delivery in September, 1957. The data presented are intended to show typical performance characteristics of the propulsion machinery during the official sea trials and during service voyages before and after modifications to the turbines.

The operating difficulties enumerated are those which are considered to be of major importance or are peculiar to free-piston machinery. Minor difficulties which are normally expected in any new design propulsion system are not mentioned.

The first part of this paper deals with the ship-log data and experience of the *John Sergeant* primarily associated with the ship's commercial voyages beginning with voyage No. 2 through voyage No. 11. The second part of this paper deals with trial data and commercial voyages of the *William Patterson*.

A Lightweight 8000-Hp Gas Turbine for Marine Propulsion............................59—GTP-18

By Vincent Proscino, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

An experimental 7500-hp, variable-speed, 8000-rpm gas turbine has been developed by Westinghouse in conjunction with the Bureau of Ships. The lightweight, medium-life (500-1000 hr) turbine engine combines the qualities of a fully developed aircraft turbojet engine with a commercial gas turbine to produce a power plant applicable to marine propulsion. The engine is capable of power output in excess of 8000 hp.

The basic turbojet is coupled to a mechanically independent turbine where hot gas, formerly converted to thrust for aircraft propulsion, is expanded through a single-stage turbine wheel to generate shaft power. The power plant is 18 ft long, $6^1/_2$ ft high, and $7^1/_2$ ft wide (maximum dimensions of the exhaust hood) and weighs 8100 lb. A comparable commercial gas-turbine power plant with equal power output would weigh 30 tons and occupy approximately twice as much space.

The 75-MV engine was conceived to meet the needs of special applications in naval marine service by providing readily available high-power potential in a small package. The engine can be used in combination with other plants for supplementary power purposes or as a main propulsion unit as the application may require. The high-power capability provides an ideal unit for filling peak power demands of an intermittent nature on large ships. On smaller vessels, confined to short operating ranges, it can serve as the main propulsion unit.

A detailed description of the engine is given along with a discussion of engine development.

The engine has been developed to burn diesel fuel, and has demonstrated the ability to run 500 hr at full load, indicating a normal service life of 1000 hr between overhauls.

Description and Service Experience of Various Boeing Gas-Turbine Marine Applications...59—GTP-8

By V. A. Yeager, Boeing Airplane Company, Seattle, Wash. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

All Boeing production turbines to date are classified in what is known as the 502 series. Both shaft-power and air-compressor versions of this series engine have been produced. Basically, a 502-series engine is a two-shaft gas turbine in the 150 to 300-hp range, having a gas-producer section and a power-output section which are gas-connected only, and mechanically separate. The gas-producer section, which is identical for a shaft-output engine and its air-compressor counterpart, consists essentially of a single-stage centrifugal compressor, two through-flow burners, and an axial-flow turbine wheel, shaft-connected to the compressor impeller.

Rated speed of the gas-producer rotor is 36,500 rpm. The power-output section contains a second axial-flow turbine wheel with a rated speed of approximately 25,000 rpm, which in the case of the shaft-power engine drives the output shaft, through reduction gearing, at about 3000 rpm (with other output shaft speeds optional). In the air-compressor engine, the second-stage wheel directly drives a centrifugal "load" compressor.

This paper gives a brief description of the Boeing small gas-turbine engine and describes the various marine applications, both propulsion and auxiliary, in which these engines have served. A discussion is included concerning the major problems and corrective action associated with the initial marine service of the latest production model engine, the 502-10C. The paper concludes with a summary of service analysis data of the 502-10C engine in marine applications.

Design Considerations for Nuclear-Aircraft Gas-Turbine Engines...........................59—GTP-13

By D. Riley, Assoc. Mem. ASME, General Electric Company, Cincinnati, Ohio. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

Many new design considerations are encountered in the design of nuclear aircraft gas-turbine engines. The effect that the power-plant configurations, the cycle, radiation level, residual radiation, and nuclear heating have on design is discussed in this paper.

Among the many proposed nuclear-aircraft systems several are discussed. They include: (*a*) nuclear turbojet utilizing an intermediate heat-transfer agent; (*b*) nuclear turbojet utilizing a closed-cycle system; (*c*) nuclear ramjet utilizing a direct-air-cycle system.

In the direct-air-cycle system the engine operation is standard except that air is heated by the nuclear reactor rather than by combustion of fuel. Inlet ram air in a direct-air-cycle turbojet system passes through the compressor into a nuclear reactor where the air is heated in the reactor core. The heated air from the reactor is discharged into the turbine and passes through the turbine and out the exhaust nozzle. A turboprop direct-air-cycle system operates the same as the turbojet system, whereas the ramjet direct-air-cycle system eliminates the compressor and turbine sections. The air cycle seems to involve the least complexity and consequently minimizes the new gas-turbine-engine design problems that will be encountered in the development of a system for flight purposes.

Chief among the design problems encountered in nuclear-aircraft gas-turbine engines is the radiation level at the center of the reactor. The following new design considerations are dictated by this condition:

1 Radiation damage.

2 Nuclear heating of structural members resulting in high metal temperatures and thermal stresses and deflections.

3 Residual radiation in those parts that must be moved for maintenance.

These considerations are discussed and realistic approaches to solutions are offered.

Summary of Design Studies of a 250-Hp Gas-Turbine Engine...........................59—GTP-7

By S. H. Spooner, U. S. Army Transportation Research and Engineering Command, Fort Eustis, Va. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

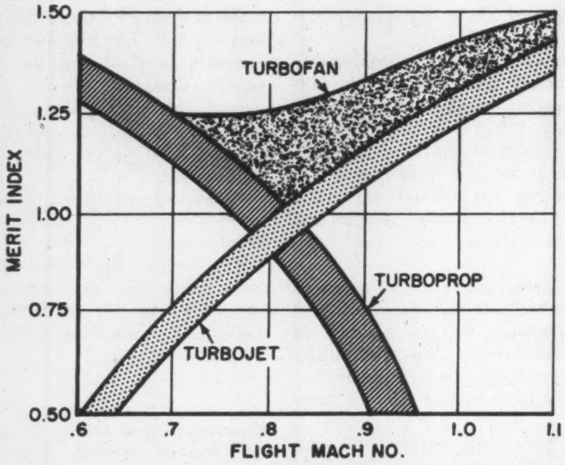
In 1956, the Department of the Army decided that, to improve the capabilities of its future aircraft, the development of new, lightweight power plants was required. It was thought that gas-turbine engines would, on the basis of their low-specific-weight characteristics, offer greater potential than reciprocating engines. Furthermore, a free-shaft gas-turbine engine, because of its inherent capability of nearly constant power output over a fairly wide rotational speed range, would be more desirable than a fixed-shaft gas-turbine engine. In addition to the major advantage of a gas-turbine engine, which is its low specific weight, a number of other advantages are: relatively small size, short warm-up time, capability of starting at low temperatures, low oil consumption, and lower vibration level than reciprocating engines. The disadvantages of the turbine engine are its higher fuel consumption, compared with reciprocating engines, and the higher cost per engine.

The probable power requirements for Army aircraft, of the 1960 through 1970 decade, indicated that a 250-hp engine would be the size to develop for use in both single and multiple-engine applications. Consideration on which this 250-hp size were based included altitude and temperature effects on power, reserve-power requirements, helicopter tail-rotor power requirements, and transmission losses.

In view of the foregoing, the Army awarded contracts to four engine manufacturers for parametric design studies of an engine which would have the following characteristics:

It would be a free-shaft, turbine-type engine and have a 30-min military rating of 250-hp under standard sea-level conditions. Also, it would have the capability for operation in single or multiple-engine configurations with basic designs, or modifications thereof, adaptable to helicopters, fixed-wing aircraft, and possibly STOL/VTOL aircraft. The weight and fuel consumption are of major significance and should be a minimum commensurate with other requirements. The over-all dimensions should be minimum but should not compromise engine efficiencies. The engine should operate in an attitude range below horizontal to vertical. Use of critical materials should be kept to a minimum. The engine would normally be operated on JP-4 fuel; however, it also should be capable of operating on aviation gasoline as an alternate fuel.

The work performed under these contracts for the parametric studies was completed early in 1957. This paper describes the results of the parametric design studies and summarizes the thinking of these four engine manufacturers regarding a general-purpose 250-hp aircraft gas-turbine engine.



Cruise range comparison for medium-range transport shows relative merits of the turbojet, turboprop, and turbofan (58—GTP-20)

A Transport Aft-Turbofan.............................59—GTP-20

By B. E. Sells and W. R. Dodge, General Electric Company, Cincinnati, Ohio. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

A new type aft-turbofan aircraft power plant has been developed by the General Electric Company by converting the CJ 805-3 commercial turbojet. The successful development of the aft-fan engine, CJ 805-21, has demonstrated the feasibility of a major increase in power rating and a significant improvement in altitude cruise fuel economy. The current technical status of the new-type engine is described.

The various types and configurations of power plants known as "turbofans" possess the desirable qualities of the propeller and the jet and do not have their limitations. In addition, they are reported to have superior performance capabilities at high subsonic flight speeds.

The General Electric aft-fan has several unique technical and economic advantages. This engine is the commercially available General Electric CJ 805-3 turbojet, with rear bearing support frame and exhaust system of the turbojet replaced by the aft-fan as a single added component.

The resulting engine, the CJ 805-21, benefits from thousands of hours of experience in both factory and flight test on the basic CJ 805-3 turbojet. The end product reflects the savings in engine development and tooling costs, minimum additional special assembly tools, and shorter delivery schedule than possible for a completely new power plant.

Adding the aft-fan to the CJ 805-3 turbojet has increased its rating from a thrust class of 10,000 lb to a thrust class of 15,000 lb. Take-off thrust has been increased more than 40 per cent with the same fuel flow; thrust-to-weight ratio of the aft-fan engine has increased over eight per cent from the turbojet; and cruise altitude fuel consumption has improved 10 to 15 per cent.

A significant requirement to achieve CJ 805-21 aft-fan performance was the development of the fan compressor. Compressor-design parameters as well as mechanical arrangements of the aft-fan component, and compressor blade and turbine bucket or "blucket" are treated in some detail.

The Past, Present, and Future of a Pipeline Gas Turbine.............................59—GTP-19

By A. H. Cameros and B. J. Mathews, El Paso Natural Gas Company, El Paso, Texas; and W. B. Mayer, General Electric Company, Schenectady, N. Y. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

Experience with gas-turbine operation on the El Paso Natural Gas Company system is reviewed. The original 28 turbines on the companies system are of the two-shaft, regenerative-cycle type fired at 1450 F and rated at 5000 hp at 80 F and 1000-ft altitude. The turbines have since been up-rated to 5700 hp.

The initial requirements of the gas turbine—high reliability and availability, adequate flexibility, low installation costs, and low operating costs—are set forth. The means by which these requirements have been fulfilled are discussed. Problems encountered with respect to design, operation, and maintenance are noted. Desirable improvements in the gas turbine and associated equipment are also discussed.

Six years of gas-turbine operation has proved that it is a reliable gas pipeline prime mover which fills all the requirements needed to operate successfully on a large pipeline system.

Operating Experience in the Petro-Chemical Industry.....59—GTP-17

By J. O. Stephens, Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

Over the past 12 years of Westinghouse industrial gas-turbine operating experience, a line of machines has been developed that offers the petro-chemical industry considerable flexibility in mechanical and electrical drives as well as many variations in combining the gas-turbine cycle with a given process.

To this line of machines in the larger size range, prototype performance tests have recently been completed on the W-121 frame. This is rated 8500 kw or 12,000 hp and shop tests have proved the capability is considerably in excess of this rating.

New features such as improved turbine sealing, rotor and cylinder cooling, and combustor-transition design contributed to meeting all design expectations and indicate that higher turbine temperatures with increased power and improved efficiency are practical for the near future. Currently in process of manufacture is a 125,000-scfm extraction machine where this quantity of air is extracted between the axial-flow compressor and the turbine at a pressure of 35 psig while being fired with low Btu gas of 90 to 100 Btu/cf. This new frame is currently designed for burning blast-furnace gas; however, it is capable of operation on similar low Btu refinery gases, which provides an efficient means for utilization of this recoverable energy.

One basic feature of the gas turbine for the petro-chemical industry is its ability to generate power and compress air at the same time. Although a machine used for both jobs is not as efficient as a machine designed for a single job, the ability of a power-generating unit to deliver compressed air in an emergency can greatly alter the plant's spare compression or spare generating investment.

With the ever-increasing number of proved gas-turbine frames to choose from, it is expected that the petro-chemical industry will increase its application of the gas-turbine power plant. It offers many advantages that process designers should carefully investigate in any plans to modernize or expand existing process plants, as well as integration into new process developments.

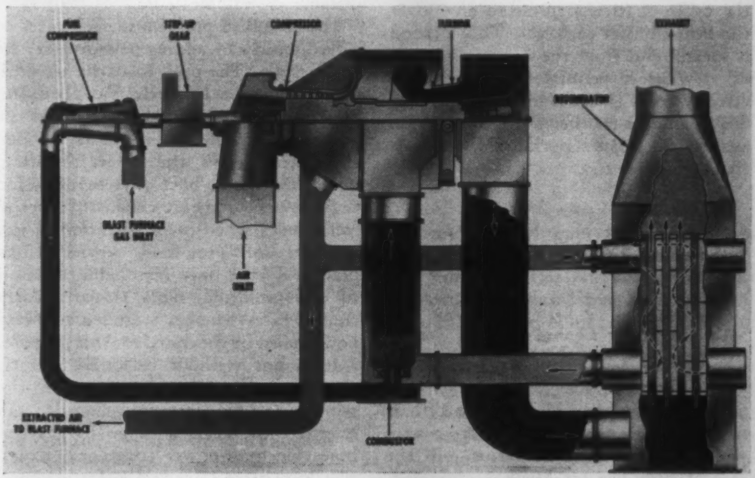
Development of a Three-Stage Liquid-Cooled Gas Turbine........ ....59—GTP-1

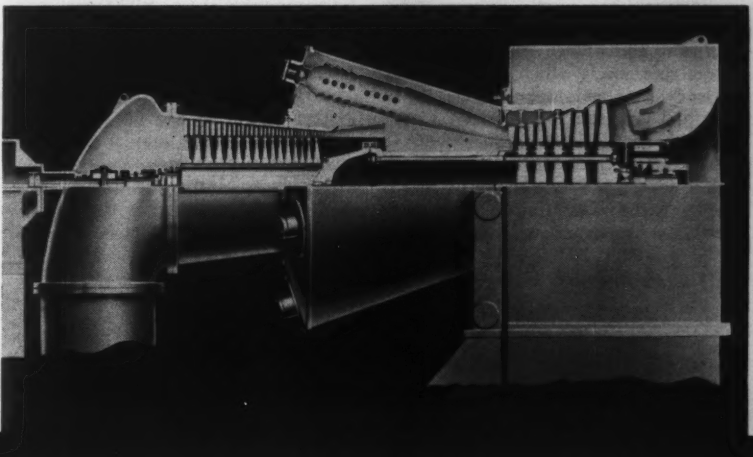
By Sumner Alpert, Mem. ASME, R. E. Grey, and W. O. Flaschar, Solar Aircraft Company, San Diego, Calif. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power,* available to Jan. 1, 1960).

A three-stage gas turbine was designed to operate at 1750 F inlet temperature with nonstrategic, low-alloy components.

This paper describes the design and test work conducted during the development program. It is a continuation of a paper, "Application of Internal Liquid Cooling to Gas Turbine Rotors" (see Trans. ASME, vol. 78, 1956, pp. 1257–1266).

The program sponsored by the Bureau of Ships, U. S. Navy, had as its objective the development of a gas turbine that would utilize little or none of the so-called strategic materials: nickel, chromium, molybdenum, tungsten, cobalt, columbium, beryllium. The rotor blades are cooled with a closed cooling system, and stators are cooled with air. A practical design for the rotor was evolved and tested. Heat-transfer data correlated well with expected values.





Cross section of a 125,000-cfm extraction-regenerative gas turbine equipped to burn low Btu gas, *top* (59—GTP-17)

Cross section of 5500-kw gas turbine, one of a line of machines offering the petro-chemical industry considerable flexibility, *bottom* (59—GTP-17)

Relative Thermal Performance of Carbon Dioxide and Helium in Nuclear-Power Cycles...59—GTP-14

By F. E. Tippets, Assoc. Mem. ASME, General Electric Company, San Jose, Calif. 1959 ASME Gas Turbine Power Conference. paper (multilithographed; available to Jan. 1, 1960).

Interest in the gas-cooled power-reactor concept has raised questions regarding the relative merits of various gases as heat-transfer and thermodynamic working fluids in nuclear-power cycles. For various reasons of availability, chemical behavior, and thermodynamic characteristics, the most likely choice is among carbon dioxide, nitrogen, and helium.

The purpose of this paper is to report the results of an analytical comparison of the heat-transfer characteristics and thermal performance of carbon dioxide and helium in typical nuclear-power cycles. Both the gas-cooled reactor steam turbine system (indirect cycle) and the gas-cooled-reactor gas-turbine system (direct cycle) are considered. A limited comparison of reactor heat-transfer surface-area requirements is also made between the indirect cycle and the direct cycle for both gases.

Heat-transfer-area requirements are compared principally on the basis of specified fractional decrements of cycle efficiency due to the over-all effect on the cycle of friction pressure drop over the heat-transfer surfaces. This method is meaningful from the designer's point of view as it permits him to balance directly costs of losses in cycle efficiency due to heat-transfer surface friction against the costs associated with heat-transfer surface area.

Performance of Plug Nozzles for Turbojet and Rocket Exhausts.......................59—GTP-9

By W. H. Krase, The Rand Corporation, Santa Monica, Calif. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

The design of turbojet and rocket-jet nozzles is complicated by the fact that, in many cases, they must operate over a wide range of pressure ratios. In the case of turbojets for Mach 3 operation, for instance, the nozzle pressure ratio may vary from about 2.5 at take-off conditions to as much as 30 at Mach 3. To design a nozzle which will give high efficiency over this speed range is, in principle, very simple and requires only a suitable change in the geometry of the nozzle. The practical realization of such a nozzle, however, is by no means simple, being complicated by requirements for throat as well as exit-area variation, by space limitations for actuators, the shape and length required for good internal performance and low external drag, and by various mechanical problems of seals, sliding hot surfaces, and the like.

Although it is not proposed that the plug-type nozzle resolves any or all of these problems, it represents one of several possible solutions to the design problem.

An attractive feature of the plug-type nozzle for turbojets and rocket jets is that it can automatically adjust its effective exit area with operating pressure ratio and achieve a high level of efficiency over a wide range of operating pressure ratio without variation of mechanical shape. The design and off-design performance analysis of such nozzles is described.

40,000-Kw Gas-Turbine Power Plant—Mayagüez, Puerto Rico..........................59—GTP-11

By Z. Stanley Stys, Assoc. Mem. ASME, Brown Boveri Corporation, New York, N. Y. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

The two basic problems in power generation, namely, base-load and peak-load generation, appear in particularly clear form in isolated systems, for instance, on a small island.

The base-load problem in such cases is solved mostly by adding new capacity to the system. The peak loads are covered by storage-type hydroelectric plants or by putting old steam-turbine units in periodic operation. The more rapidly the system grows, the sooner the limit is reached where both these sources for peak-power supply are exhausted and the time comes when the application of gas turbines for peak-load service offers practically the only reasonable solution to the problem. This is particularly true in cases where a sizable amount of power must be generated for this purpose.

It is not without reason, therefore, that the fastest growing areas in the world, as, for instance, Canada and Puerto Rico, decided to go to gas turbines for peak-power coverage. Examples in western Canada are, for instance, Edmonton, with a 60,000-kw power plant, and Vancouver with a 120,000-kw power station; in Puerto Rico, the Mayagüez 40,000-kw gas-turbine plant.

A review of the power-generation system in Puerto Rico is given. Two plants which have similar operational characteristics—Beznau, Switzerland, and Livorno, Italy—are treated briefly. A detailed description is then given of the Mayagüez power plant.

Torsion of a Prismatical Bar Whose Section Is a Crescent...59—GTP-6

By F. Sisto, Stevens Institute of Technology, Hoboken, N. J. 1959 ASME Gas Turbine Power Conference paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Jan. 1, 1960).

The Saint Venant torsion problem is solved for a region bounded by two circular arcs forming a crescent. The region is conformally transformed to an infinite strip and the stress function is obtained by Fourier integral. Subsequent quadratures for evaluation of the torsion constant are obtained explicitly with the exception of a single infinite integral which may easily be evaluated numerically. Some values of the torsion constant are given, and an approximate formula valid for small "camber" is presented.

Application of Electrical Analog Theory in the Preliminary Design of Air-Cooled Turbines...59—GTP-15

By R. Lang and E. N. Petrick, Curtiss-Wright Corporation, Quehanna, Pa. 1959 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1960).

The demand for increased performance in turbojet engines has necessitated an increase in the operating temperatures of various engine components. To this end, metallurgical engineers have made significant improvements in the properties of high-strength metals. The metallurgical state of the art, however, is not sufficient to satisfy the requirements of the propulsion engineer. The air-cooled turbine, therefore, has been developed. The higher operating temperature levels require a more critical study of temperature distribution and of the resultant operating stresses in the blading.

The utilization of the analogy between heat flow and electrical flow is described herein as the basis for a method of determining the chordwise-temperature distribution and heat-transfer rates in the air-cooled turbine blades. A general review of the mathematical derivation of analog theory is included and a hypothetical problem is solved.

It is to be noted that the technique is not restricted solely to the turbine problem, but can be applied to any steady-state problem which satisfies the specified conditions. Additional analog examples are cited, including techniques for determination of the velocity and pressure distribution around the turbine blade and the temperature distribution in an air-cooled turbine disk.

Heat Transfer

Study of Existing Data for Heating of Air and Water in Turbulent Flow in Inside Tubes........58—A-298

By M. Al-Arabi, Cairo, Egypt. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Data available for heating air and water in turbulent flow inside tubes have been studied. The correlations made have shown that the usually accepted equations of Dittus and Boelter, Colburn and Seider, and Tate do not well represent the results for a "tube of infinite length." As used by the author, this term refers to such tubes for which the length-to-diameter ratio is high enough to enable the length effects to be neglected. Modified equations are suggested.

The water data had to be divided into two groups, a group for "low-temperature heating" and a group for "high-temperature heating." The two groups do not follow the same line and are represented by different equations.

Management

Why More Engineers Are Not Considered for Administrative Positions..................58—A-163

By V. Donald Schoeller, Mem. ASME, Remington Rand Division, Sperry Rand Corporation, Stamford, Conn. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Administrative positions, as discussed in this paper, include all positions above chief engineer or director of engineering division in an industrial establishment.

A director of engineering research, for example, in a large and complex industrial organization may well encompass a wide range of administrative activities dealing with administrative management functions of the pure engineering, but it is not certain that he will have contact with the marketing, production, financial, and legal aspects of the business.

The author suggests that in developing administrative abilities it is necessary to cultivate "universal" rather than "unilateral" approaches.

Examples of administrative control are cited.

Also considered are seven areas of specialized managerial activity which, if allowed to operate in a unilateral control position, can cause repercussions that may wreck a business. The seven areas are: marketing, manpower, materials, money, methods, and managerial administration.

Employment Stabilization.................................58—A-182

By J. F. Magee, Arthur D. Little, Inc., Cambridge, Mass. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Businessmen must help stabilize employment. To do this they must do an improved job in controlling and stabilizing inventory fluctuations. Economists and analysts have demonstrated the application of servo principles and the concept of feedback in controlling business operations. It has been shown how this information throughout the whole distribution system can affect its stability. Business is just beginning to pay serious attention to the use of feedback principles for some production control.

Power Test Codes

Power Test Code Thermometer Wells................58—A-176

By J. W. Murdock, Mem. ASME, U. S. Naval Boiler and Turbine Laboratory and Drexel Institute of Technology, Philadelphia, Pa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

Design of thermometer wells involves strength and thermal considerations. Criteria for thermal evaluation have been well established, those for strength have not. This paper presents thermometer-well designs proposed for Power Test Code work. Forces imposed by static pressure, steady-state fluid impingement, vibration induced by von Karman trail vortexes, and structure-borne vibration are discussed. Methods and equations are given to enable the selection of wells for given service conditions. Although these methods are confined to wells of Power Test Code design, the Appendix contains derivations of general equations that may be adapted for any cantilever-type thermometer well.

The Calibration of Thermocouples by Freezing-Point Baths and Empirical Equations.........58—A-175

By R. P. Benedict, Westinghouse Electric Corporation, Lester, Pa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Power;* available to Oct. 1, 1959).

A calibration system is described which is based on the use of a few precisely determined experimental values obtained from freezing-point baths. Characteristics of the individual thermocouples at intermediate points are obtained by passing empirical equations of prescribed form through the test values. A program is reviewed, by which a high-speed digital computer accomplishes the necessary conversions, curve fittings, comparisons of individual characteristics with arbitrary reference tables, and the printing out of a table of differences. Test results for a series of iron-constantan thermocouples, over the temperature range 32 to 1225 F, are presented to illustrate the use of the system and the uncertainties involved. Comparisons are drawn between these results and those obtained by other methods.

Fuels

Trouble-Shooting Mechanical Dust Collectors.............58—A-283

By W. E. Archer, Assoc. Mem. ASME, Western Precipitation Corporation, Los Angeles, Calif. 1958 ASME annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Community concern with problems of air pollution is making the efficient operation of mechanical dust collectors increasingly important. In addition, primary equipment employing dust collectors is now operating at higher average load conditions and for considerably longer periods of time between maintenance shutdowns.

Optimum dust-collector performance is required, but is dependent upon optimum operating conditions. For this reason maintenance trouble-shooting is essential. By utilizing every outage period to make a careful inspection of the collector and its associated ducting, the engineer often can forestall trouble or remedy it while it is still minor.

Before the engineer can interpret properly the evidence presented by careful inspection of a mechanical dust collector, he should have a sound understanding of the operating principles of the unit.

The basic principles of operation are common to all mechanical collectors.

The collector itself consists of four elements: a spinproducing device, a collecting tube, outlet tube, and hoppers.

The spin-producing device is sometimes a vane; however, it may take any of several forms. The function of the vane is to accelerate and provide rotation to the gases passing through each tube.

The collecting tube is a cylinder in which the actual separation of the suspended dust takes place. A concentrated layer of dust forms at the periphery of the vortex, near the wall of the tube. An appreciable pressure gradient exists, expelling the dust from the bottom of the tube.

The clean gases leave the collecting tube through an outlet tube. The components are mounted between tube sheets in such a manner that the gas stream is forced to pass through the entire bank of tubes operating in parallel.

The hopper is usually common to a large number of tubes. The deposited dust is removed from the hopper by a dust-handling system.

Mechanical-collector problems fall into two classes: pluggage due to hopper overfilling, and accelerated wear as the result of poor dust distribution in the gas stream.

This paper points out that preventive and corrective maintenance for mechanical dust collectors cannot be reduced to a fixed formula. It outlines the type of common-sense approach that must be brought to trouble-shooting mechanical dust collectors.

Production Engineering

Self-Excited Vibrations in Metal Cutting...............58—A-189

By N. H. Cook, Massachusetts Institute of Technology, Cambridge, Mass. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.;* available to Oct. 1, 1959).

The basic mechanisms which cause self-excited vibrations of a cutting tool relative to the work are discussed in a qualitative manner. Similarly, mechanisms inherent in the cutting process which can damp or limit vibrations are discussed. Experiments are presented which are in agreement with the theory.

The Effects of Recent Industrial-Diamond Developments...58—A-180

By C. L. Fanning, General Motors Institute, Flint, Mich. 1958 ASME Annual Meeting paper (multilithographed; available Oct. 1, 1959).

Recent developments in the industrial-diamond business will have profound beneficial effects in this country. As a result, our supply of diamonds will be substantially augmented, our diamonds will be more effectively used, inventories will be reduced substantially, and new jobs for diamonds will be created. In this paper an attempt is made to bring together pertinent information from which some conclusions and recommendations can be made, which will be of interest to the purchaser of industrial diamonds.

Scientific attempts to produce diamonds have been made ever since it became known in 1797 that the diamond is elemental carbon. Claims of success have been made, but none could be substantiated by a repeatable process until General Electric announced success early in 1955.

The scientists had only to duplicate the conditions in nature some 240 miles below ground. Carbonaceous materials had to be subjected to the combined high temperatures and high pressures estimated to exist at this level. This meant pressures of $1\frac{1}{2}$ million psi and temperatures of 5000 F. The almost unbelievable job of getting these conditions is a closely guarded secret. The United States Government has placed secrecy orders on the patent applications covering the process and the equipment.

The manufacture of man-made diamonds with their use and limitations, the use of oriented vectors in reducing the cost of quality dressing of grinding wheels, the recent standardization of diamond tool shanks and its effect on inventories, and various approaches to the classification of industrial diamonds are treated. Some effects of recent industrial-diamond development follow:

1 Man-made diamonds can become competitive with bort for use in many grinding-wheel applications. Quality is shown to be superior to bort for most grinding wheels, but the price is higher. As production equipment and technique are improved, they will compete.

2 Man-made diamonds will make the United States less dependent upon Africa for diamonds. The supply will be unlimited except perhaps in size of stones.

3 Oriented-vector diamond tools will have a definite place in quality wheel dressing, but there will always be a wide field of use for small natural diamonds where a less expensive tool can do the job. Some standard prices of diamonds will be disturbed when oriented vectors become available in quantity.

4 Inventories of diamond tools can be reduced materially by insistence that the tools listed in ASA Standard B67 be used in all possible applications. Special shanks will always be required for certain jobs, but the customer must insist that machine-tool builders, manufacturers of wheel-dressing fixtures, and diamond toolmakers adhere to this standard whenever possible.

5 Industrial diamonds can be standardized in nomenclature, shape, and quality and the job should be done by the diamond industry with some help from the user.

Boiler Feedwater Studies

"Thermiatrics," the Diseases of High-Temperature Boilers...............................58—A-277

By D. E. Noll, Hall Laboratories, Division of Hagan Chemicals and Control, Inc., Pittsburgh, Pa. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The "thermiatrics" of the title refers to the difficulties encountered in boilers operating at high temperatures.

The role that heat plays in tube failures is not a new one; it is merely more important than it was when failures could be diagnosed as the result of the insulating effect of deposits or the concentration of boiler water beneath them. Improved technology in the field of water conditioning has virtually eliminated the distress resulting from deposits of sludge and scale containing elements that enter with the make-up. Modern techniques for treating condensate have diminished the role that corrosion deposits play in failures.

The most damaging problems in high-temperature boilers are those associated with formation of iron oxide in areas of high heat transfer.

Recent investigations suggest that dense, adherent oxide formations are best explained by a diffusion process in which temperature is the most significant factor affecting the rate of oxidation. Modification of boiler-water chemistry does not appear to provide the solution to all types of tube failures.

One Utility's Experience With Filming Amines...........58—A-262

By J. P. White, Mem. ASME, Arkansas Power and Light Company, Little Rock, Ark. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959)

Experience with filming amine indicates that it is another tool to be used in boiler-feedwater system protection. In the station where it was first tried, indications are that the system is well protected and the cost is somewhat less than through the use of other methods. Operation is certainly simpler.

At the other stations sufficient time has not elapsed to give the final answer, although it appears the results will be competitive with other treatments.

To date, the filming amine has given better protection from copper pickup than either neutralizing amines or no treatment. The filming amine in the 100-mw unit has not proved quite as effective at eliminating iron pickup as the neutralizing amine, but this may be due to insufficient time to clean out the condensate feedwater system completely.

Even at the present stage of cleanup, iron pickup is much less than experienced with no treatment. The use of filming amines is not without its problems.

It has cleaning action and a tendency to bind iron and copper oxides into a sticky substance on the low-temperature part of the system. This may not be a bad feature since usually this is the easiest portion of the system to clean, and this serves as a means to collect and remove these oxides from the cycle before they get into the boiler.

Initial Operating Experience With Monotube Once-Through Boiler at Subcritical Pressure....58—A-286

By J. D. Williamson, Mem. ASME, The Dayton Power and Light Company, Dayton, Ohio. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Dayton Power and Light Company, in June, 1958, put into service the first monotube once-through steam boiler to be operated at subcritical pressures in the United States. This paper describes 3½ months of operating experience with the unit.

The decision to use the once-through-type steam generator for subcritical pressure operation was based on the following considerations:

1 Valuable experience would be obtained with a type of steam generator suited to the supercritical pressures of the future.

2 The design offered the possibility of lower capital costs.

3 Flexibility for turbine starts and load control would be obtained.

No difficulty was experienced with the first start-up, and with the exception of a 37-day outage period due to damage to the deaerator; troubles were generally those experienced with early operation of a conventional unit.

Feedwater and pressure-difference valves (two each per boiler) in one circuit in use with subcritical monotube once-through steam generator (58—A-286)

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Aviation

Suitability of Solid and Liquid Rocket Engines for Placing Manned Satellites in Orbit.....59—AV-23

By Martin Goldsmith, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Many comparisons of differing rocket-engine systems for various missions restrict themselves to performance considerations (as represented by minimum gross weight) only. Experience has shown that operational considerations are often more important in determining true mission cost and suitability.

The problem of placing large manned satellites in orbit, using chemical rockets, is examined in this paper with special emphasis on those factors influencing over-all cost of feasibility.

Problems associated with the placing of a one-man satellite in space are discussed. Operational reliability, guidance, flight environment, liquid and solid propellants, and acceleration are treated.

Fuel development and cost comparisons for placing large manned satellites in orbit are also discussed.

Propulsion Requirements for Space-Station Erection........59—AV-17

By J. A. Bottorff and H. B. Ellis, Aerojet-General Corporation, Azusa, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Rapid advances in rocket and space technology will lead eventually to the establishment of a manned space station. The first true, manned space station probably will be assembled in an orbit around the earth. The personnel for construction of the space station, as well as the materials of construction, will have to be transported to the desired location in space by a rocket vehicle, probably launched from the earth. During the construction phase of the space-station erection, there will be a need for auxiliary-propulsion power units for transferring both personnel and material from the launching vehicle to the construction site.

For the purposes of this paper, only propulsion systems which are applicable to the actual construction phase of the space station will be considered. The propulsion requirements for reaching the desired position in space where the station is to be erected is beyond the scope of this paper. Some of the more important requirements which must be met by a propulsion system which is to be utilized in the erection of a space station are: (*a*) Safety and reliability; (*b*) versatility; (*c*) high performance.

To best fulfill the requirements of maximum safety, reliability, versatility, and performance, auxiliary propulsion systems for use in the erection of a space station will operate with storable, hypergolic propellants. Low chamber-pressure operation offers attractive design features including safety, simplicity, and reduced system component weight. Satisfactory solutions to the apparent problems associated with the design of these propulsion systems can be obtained by proper research and development effort.

Economic Considerations of Space-Flight Ground-Support Requirements................59—AV-15

By M. A. Margolis and F. S. Pardee, The Rand Corporation, Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

An examination of United States space planning in so far as it has revealed itself from an economic viewpoint with particular emphasis on ground-facility requirements is given. The essentially developmental nature of space exploration is pointed out and, as a result, the necessity of estimating system requirements in the face of continued program changes. While this mode of operation is uneconomical, it is the product of the uncertainties of the development process. Cradle-to-grave requirement estimations for alternative programs, and measurement of the sensitivity of space programs to those variations which a priori seem most likely to occur, are suggested as a means of building flexibility into development planning.

The advantages of using components in space exploration which have already been developed for alternative uses are discussed. A number of the facets of the present ballistic-missile programs which have had a significant impact upon ground-system costs and which will carry over to space exploration are cited. They include the growing importance of assembly, test, and calibration relative to machining and other fabrication labor; the trend toward more highly instrumented hardware; the increasing volume of high-cost test equipment procured; and, finally, the increasing relative cost of ground facilities.

Space exploration has been divided into two time periods for discussion purposes—one beginning with the present and extending three to five years into the future, during which space systems develop out of and continue in many ways to resemble ballistic-missile development programs; and a second period considerably later in time and characterized by manned flights.

This paper outlines briefly the variety of space-flight facilities required in order that the economic considerations involved in the procurement and construction of these facilities may be pointed out. The problem of when to increase the number of operating space facilities and the criteria for such decisions is discussed. These criteria include traffic volume and its effect upon program management, the relative hazards of employing high-energy propellants, and the geographical requirements of specific space missions. Optical and radio tracking facilities are discussed along with ground-site requirements, both for the recovery of orbital capsules and the problem of landing manned vehicles. The economic advantages of employing recoverable boosters during the same future period and the possible effects of such flight systems upon base design are pointed out.

Trends in Ground Support Equipment for Surface-to-Surface Missiles Including Manned Satellites... ....59—AV-51

By H. R. Hammond, Food Machinery and Chemical Corporation, San Jose, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

There are some fairly definable trends in the design of ground support equipment for the field of surface-to-surface missiles and some lesser defined trends with respect to the support equipment for the satellite vehicles. In the relatively short-range surface-to-surface missile systems, we can identify very vigorous trends in ground support equipment design to make it capable of supporting the mobile field organizations now being developed within the Army. Looking at larger weapons which can be described as strategic weapons systems manned by Air Force units, there is a definite trend from soft, unprotected installations to hardened sites in which there is some over-all protection for all the elements of the weapons system. There are indications of a third mode, this being an over-all mobility concept.

The trend of ground support equipment design for the satellite programs is less defined. Larger, higher thrust level vehicles, some of which are under development today, some of which are being talked about, will require heavier and larger launching and handling equipment than are presently in use.

A summary of design trends of mechanical ground support equipment for tactical surface-to-surface missiles and larger strategic type missiles is presented. A brief discussion is given of some satellite vehicle problems as they may affect trends in such vehicle ground equipment.

On-Site Loading of Solid Propellants for Large Missile and Satellite Launching Units....59—AV-19

By W. F. Haite, Thiokol Chemical Corporation, Redstone Division, Huntsville, Ala. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Launching of inhabited earth satellites, establishment of space stations, and space travel to the moon cannot be realized without rockets developing thrusts greater than the many millions of pounds take-off weight. Large solid-propellant rocket motors provide a practical method of obtaining the large values of thrust required for such applications.

Escape velocities can be obtained at certain linear ratios between take-off weight and payload. Assume that escape velocity can be accomplished with a ratio of 1000 to 1. Based on present technology, this assumption is logical. Any reasonable manned vehicle made of present materials would weigh at least 5000 lb. If the assumed ratio is valid, this means a total take-off weight of 5,000,000 lb for a multistage system. With a thrust-to-weight ratio of 2, considered adequate to start a vehicle in its trajectory toward space, the thrust required of the first-stage unit is 10,000,000 lb. Such a requirement is completely impracticable with rockets presently utilizing other than solid propellants.

The large-size rocket motors required are, for all practical purposes, impossible to transport with existing equipment and thoroughfares. Construction of fixed-propellant processing and motor-loading plants at each launching site would be impractical. The practical solution rests in on-site loading by use of a mobile propellant-loading plant.

This paper presents a method of loading castable solid propellants into large missile and satellite launching units in position at launching sites. The description of the method includes potential site location, motor shell erection, and design and use of a mobile-propellant loading plant.

The Reaction of People to Exterior Aircraft Noise.....59—AV-50

By L. L. Beranek, K. D. Kryter, and L. N. Miller, Bolt, Beranek and Newman, Inc., Cambridge, Mass. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Considerable work has been in progress concerned with: Propeller and jet aircraft noise; engine noise suppression on air bases and in flight; sound propagation through the atmosphere and over terrain; reaction of humans in offices and communities to aircraft noise; and planning of air bases and surrounding residential communities to minimize noise nuisance. This work has been sponsored by the United States Government, the Port of New York Authority, and to a lesser extent by other airport agencies.

Each airport and communities surrounding it constitute a special situation. A full evaluation of community disturbance by aircraft operations requires detailed knowledge of many factors. These factors differ from airport to airport and include such diverse items as distance of the nearest populated areas off the ends and to the sides of runways; type and density of air traffic; runway utilization; operational procedures of the airlines; prevailing type of home-building construction; socioeconomic status of the communities involved; and motivation and attitude of the residents toward the airport. Conclusions drawn for one airport and its activities in relation to the neighborhoods surrounding it are not specifically applicable to other airports.

The prediction of the annoyance of a neighborhood to a change in operations from that airport is not altogether hopeless. Several papers have been written giving preliminary guidance on this subject. The present paper is another progress report along these lines. It makes use of the relatively new method of rating the perceived "noisiness" of an aircraft noise called the PNdb. It also takes into account the statistical nature of the noise produced in a neighborhood off the end of a runway.

The assessment of the change in annoyance in a neighborhood adjacent to an airport due to a change in aircraft operation from that airport involves at least the following steps:

1 The assignment of a "perceived noise level" in PNdb to aircraft operations over each part of a community. This quantity may be the result of direct statistical measurement of the aircraft noise or it may be computed from a knowledge of noise data on individual aircraft and from a knowledge of the projected operations.

2 The comparison of the statistical pattern of the expected perceived noise levels for the new situation with that for some known situation. If the existing annoyance situation for the airport under consideration is already known, the effect of introducing a different type of aircraft, or of preferential runway systems, or of limiting operations to certain heights or times of day or year may be judged.

On the Generation of Noise by Turbulent Jets............59—AV-53

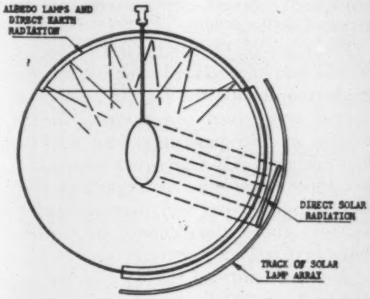
By Alan Powell, University of California at Los Angeles, Los Angeles, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Elementary methods are used to provide a fundamental understanding of the salient features of jet noise. Simple reasoning yields information about the total noise power and spectral shape which are in encouraging agreement with experiment. The possibilities of remedying certain deficiencies are discussed, and the failure of existing methods is illustrated by reference to rocket noise.

General theoretical considerations are discussed in relation to the simple source, the dipole source, and the quadrupole source. Results are obtained which parallel those of Professor Lighthill which illustrate the idea that quadrupole sources should be the principal generators of noise in an unsteady flow.

Implications concerning spectra are noted, and experimental findings are given for over-all noise power and characteristics of spectra.

Effects of convection, some jet turbulence characteristics, and rocket noise are also treated.


ALBEDO LAMPS AND DIRECT EARTH RADIATION
DIRECT SOLAR RADIATION
TRACK OF SOLAR LAMP ARRAY

Schematic of environment chamber which can simulate thermal conditions in orbit (59—AV-26)

Simulation of Thermal Environment in Space.........59—AV-26

By J. B. Cladis, Lockheed Missile System Division, Palo Alto, Calif. 1959 Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Need for a ground facility which can simulate the thermal environment in space is becoming more acute as instrumentation of earth satellites and space vehicles becomes more sophisticated.

At altitudes greater than about a hundred miles, the atmosphere is so tenuous that heat exchange between a space vehicle and its external environment occurs essentially by means of heat radiation alone. The conditions, therefore, which are to be simulated are those of an earth satellite's significant heat sources, namely, solar radiation directly from the sun, solar radiation reflected by the earth-atmosphere system, and the low-temperature radiation which is emitted by the earth-atmosphere system.

In this paper two facilities are described which can be used to test the thermal design of a space vehicle. One is capable of a high degree of simulation of the thermal conditions in space, but is costly. The other is in use at Lockheed Missile System Division.

A Procedure for Designing and Testing Aircraft Structure Loaded by Jet-Engine Noise...59—AV-48

By A. L. Eshleman, Jr., Joseph Van Dyke, Jr., and Peter Belcher, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

In the design of structure for propeller-driven aircraft an attempt is made to avoid the coincidence of resonance frequencies with the frequencies of the propeller noise.

For jet-powered aircraft, avoidance of resonant response is not possible, since jet noise is of high intensity over a wide frequency range. Thus there is assurance that structural resonances will be significantly excited.

When design of the DC-8 was begun, no practical technique was in existence for dealing with this problem. In terms of time and cost, it was not acceptable to develop the airframe by testing repeated versions of large structural components, using jet engines as the noise source.

As a reasonable alternative, a method was devised which uses testing with a high-intensity-siren, and computation from test data of the fatigue strength of the structure when loaded by jet noise.

The procedure, developed by the Douglas Aircraft Company for design of structure loaded by jet-engine noise, is outlined. A definite "tool" is provided which leads to the design of efficient structure.

The limitations of the theory and their effects on the design procedure are considered. Some typical DC-8 structures which were developed by use of these techniques are discussed.

A Quarter Century of Aircraft Seating..................59—AV-21

By Stanley Lippert, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

In the past, man's major effort in seat design has been directed toward styling and toward unique methods of construction. The suitability or acceptability of a particular seat could be defined absolutely by personal opinion.

The airplane has been responsible for the greatest effort to establish design principles and design refinements in seat construction. Airplane requirements are brought into sharper focus by rising standards of comfort forced by competition, by the increasing standards of safety which accompany new airplane design, and by the ever-present desire to minimize the weight penalty in all designs.

The design of an aircraft seat has many ramifications not apparent to the passenger.

The aircraft seat must withstand severe forces applied in a number of directions; must fit into one or more aircraft configurations; and must be light in weight. The seat must withstand a series of abuses such as standing and sitting on arm rests, pulling on the back, bumping, and so on. There are left-hand and right-hand seats, and high-density and low-density seats, which cut volume production, increase engineering time. These raise costs. The total demand for seats is low and extends over a long period of time, so that the production economy that would be possible with a large number of seats does not exist. Rapid style changes due to the race for competitive advantage bring in new seat designs one after the other. This requires engineering time and increases production costs. Airlines want their seats to appear unique to their own line. Aircraft seats must provide adequate adjustments for wide variations of domestic and international passenger populations, which populations are not yet carefully defined. The aircraft seat must be movable or track mounted to adjust for varying spacing requirements for different classes of passenger fares at stops and turn-arounds. Aircraft seats must be stowed easily and compactly; must be reliable and require minimum maintenance; and an aircraft seat must meet highly competitive prices.

In the period 1933 to 1958, which embraces the DC-2 and the DC-8 passenger seats, a number of advances in design have taken place. These are discussed by means of examples, and attention is given to the changing requirements imposed in the last twenty-five years. Safety, economy in the use of materials, comfort, and convenience are discussed.

Passenger Seat Design as Applied to the Convair 880.....59—AV-20

By L. C. Beckett, Convair, A Division of General Dynamics Corporation, San Diego, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

Experience has taught the seat designer that every man is an expert on the subject of seat comfort. He may be unfamiliar with the fact that as a five-percentile or perhaps a ninety-five percentile man, he cannot expect the seat to provide the same degree of comfort a fifty-percentile man experiences. He only knows how the seat feels to him, and his opinions in this regard are indisputable.

In the world of commercial aviation today the air traveler is confronted with a variety of aircraft passenger-seat designs. There are first-class seats, coach seats, seats with varying degrees of recline, seats with nonreclinable backs, and seats with articulated bottoms, to name a few. All of these seats were designed with the passengers' comfort in mind.

Certainly then, one of the main problems facing the seat designer is the one of finding the combination that will provide maximum comfort for the largest number of physically different people who will occupy the seat during its service life.

Finding that combination which would provide relaxed comfort of the highest order for the largest number of people was given top priority in the design of the passenger seat for the Convair 880. Of near equal importance are those considerations regarding styling, weight, cost, and passenger-safety features above and beyond the requirements of Civil Air Regulations.

A case history of the development of the Convair 880 Passenger Seat is given from inception to design completion including discussion of those features given special consideration, such as comfort, styling, safety, and lightweight durability. Basic seat-frame construction, special features, and the test-program outline are discussed.

Integration of Maximum Comfort Into the Electra Passenger Seats ....59—AV-22

By G. E. Hanff, Lockheed Aircraft Corporation, Burbank, Calif. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

In designing a passenger seat for the Electra airplane, the prime objective was to increase the standard of comfort for airline seating while holding to a seat spacing module of 38 in. and a basic weight per luxury double-seat unit of 55 lb. Simultaneously, the many other important factors such as safety, ruggedness, dependability, maintainability, and low cost had to be built into the final product.

A basic research program was conducted to determine what factors influence seating comfort. The program was conducted for Lockheed by Henry Dreyfuss Associates in co-operation with Janet Travell, M.D., associate professor of clinical pharmacology, Cornell University Medical College.

Preliminary conclusions were based on important design factors in addition to those relating to body support and comfort such as structural requirements, elimination of excessive mechanical linkages, cabin-space limitations, ease of ingress to and egress from seats, underseats stowage and leg space, and good first impression.

Close co-operation between Henry Dreyfuss and Dr. Travell was effective in correlating physical test results and physiological analysis. A widely adjustable plywood mockup chair was constructed using anthropometric data covering the range of basic human measurements to establish adjustment limits. Adjustments included seat angle, back recline, arm height, foot-rest location, floor position, and seat-back clearance. This chair was used to determine the dimensions and contours necessary for optimum comfort and to verify various features of physiological analysis.

X-ray profiles were used extensively to study skeletal positioning and soft tissue deformation in various positions. Finally, in conjunction with the optimum configuration indicated by the studies in a final mockup chair, full-size body x-ray profiles of a man and a woman were made to show the over-all effect.

Practical considerations preclude the use of different seats for persons of different stature. One seat must be used for everyone, hence the need for the one-seat configuration which affords the most comfort to the most people on an airplane flight lasting several hours.

The ideal passenger seat will satisfy the public both in its first impression and short-term reaction and in the restful comfort it provides the passenger after several hours of sitting.

On the Economy and Techniques of Large Booster Recovery.59—AV-1

By H. H. Koelle, Army Ballistic Missile Agency, Redstone Arsenal, Ala. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

One of the possibilities of reducing operational costs in space travel is by booster recovery.

Basically, booster recovery schemes

employ parachutes, wings, turbojet-assisted rocket boosters, and pure turbojet boosters. As early as 1932, certain booster recovery attempts were successful. Today, however, with increasing vehicle size and firing rates a satisfactory solution to the problem has not yet been found.

Solutions depend greatly upon the detailed assumptions for each system. Such parameters as initial vehicle requirements, recovery cost, booster rotation time, and various correction factors are defined and explained in this paper. Simple approximation formulas are derived and evaluated for an arbitrarily selected orbital flight mission.

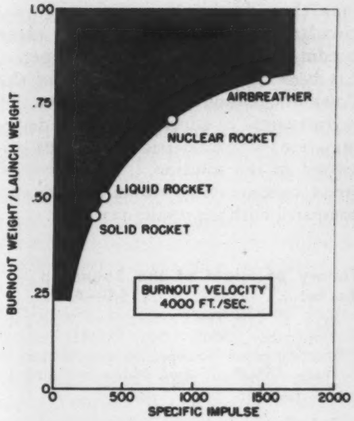
Recoverable Boost Vehicles With Air-Breathing Power Plants....................... 59—AV-16

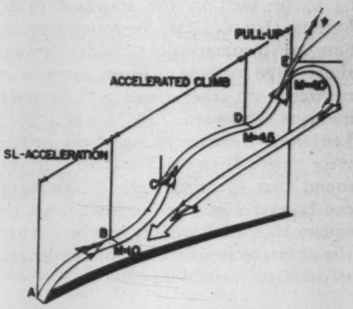
By P. G. Kappus, General Electric Company, Cincinnati, Ohio. 1959 ASME Aviation Conference paper (multilithographed; available to Jan. 1, 1960).

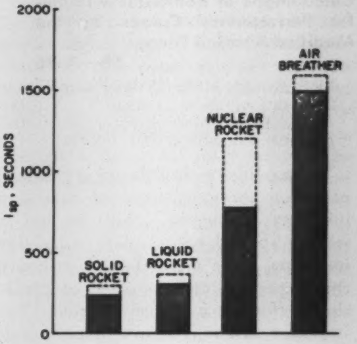
First-stage space-project vehicles are much larger and costlier pieces of equipment than the remaining components and therefore offer the greatest opportunity for potential savings. For this reason great interest has developed in recoverable, reusable first-stage vehicles, which will make possible significant savings in many areas—development, procurement, and operation.

Air-breathing power plants are discussed in this paper as potentially successful boost vehicles.

Current concepts of re-entry vehicles are based on the principle of utilizing the earth's atmosphere to absorb gradually the kinetic energy inherent in an orbiting body. It is possible to use the atmospheric air to good advantage in three different ways during a first-stage rocket trajectory:







Relationship between weight ratio and specific impulse of first-stage power plant, *top left* (59—AV-16)

Air-breathing boost trajectory is similar to that of high-powered supersonic airplanes, *top right* (59—AV-16)

Basic advantage of air-breathing boost power plants—their ability to produce more thrust for a given propellant flow—is illustrated by graph showing specific impulse of potential boost systems, *bottom right* (59—AV-16)

1 It can be used as a propulsive mass flow in order to reduce the necessary quantity of propellant to be carried in the boost vehicle.

2 It can be used as an oxidizer to liberate the chemical energy contained in the boost fuel, further reducing the needed propellant supply.

3 It can be used to support the weight of the whole assembly during the boost trajectory as well as during the recovery phase through aerodynamic lift. This is much more efficient than producing lifting forces, fighting gravity directly through a vertical thrust vector component.

In this paper first-stage vehicles using air as a boost medium are considered. Drawbacks of the air-breathing power plant are noted; boost trajectory factors and an optimum trajectory are discussed; and the air-breathing system is compared with other systems.

Some specific characteristics of the air-breathing boost vehicle are given. Its versatility, reliability, potential disadvantages, and the cost factor involved are each treated.

* * *

Hydraulics

Prediction of Critical Pressures for the Two-Phase Flow of Saturated Water in Pipes........ 58—A-112

By D. O. Stuart, Assoc. Mem. ASME, Boeing Airplane Company, Wichita, Kan.; and Glenn Murphy, Mem. ASME, Iowa State College, Ames, Iowa. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

When saturated water flows in a pipe, each incremental drop in pressure due to friction and momentum change causes a fraction of the water to evaporate. The flow of saturated water thus involves the flow of two phases, the liquid water and the vapor steam. Investigators have observed that there is a critical flow associated with the flow of saturated water. They have observed that, if the back pressure on the outlet of a pipe is continuously reduced while the inlet pressure is held constant, the pipe-outlet pressure will approach a minimum value which is not changed by a further reduction in the back pressure. For back pressures below the minimum pipe-outlet pressure, the flow is independent of the back pressure. This mode of flow is called critical flow, and the pressure on the outlet of the pipe is called the critical outlet pressure, or simply the critical pressure.

Data for the critical flow of saturated water in pipes are analyzed. It is shown that the velocity of the vapor at the pipe outlet must be in the order of magnitude of the velocity of sound in the vapor. A prediction curve for critical outlet pressures is given and compared with the available experimental data.

Coefficients of Discharge of Short Pipe Orifices for Incompressible Flow at Reynolds Numbers Less Than One............. 58—A-106

By R. P. Miller, Mem. ASME, General Electric Company, Cincinnati, Ohio; and I. V. Nemecek, Assoc. Mem. ASME, University of Kansas, Lawrence, Kan. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The object of this investigation was to determine the coefficient of discharge

C_d to be used in the standard orifice formula $Q = C_{dA}\ 2gb$, for computing the flow of incompressible fluids through short pipe orifices. Flow rates were restricted to the range of Reynolds numbers between 10^{-8} and 10^{-1}. Length-to-diameter ratios of the orifices were varied between 2 and 10. It was found that the coefficients of discharge can be expressed as a constant times the square root of Reynolds number, where the constant is a function of the length-to-diameter ratio of the orifice.

Calculations of Radial-Flow-Impeller Performance Curves by the Modified Aerofoil Theory.................................58—A-86

By A. Kovats, Mem. ASME, Foster Wheeler Corporation, New York, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The modified airfoil theory is generally used for the calculation of axial-flow impellers; however, this method is seldom applied to calculate radial-flow impellers. The method as described in this paper makes it possible to predict the performance curve of radial-flow impellers, and it is shown by test results that the calculated curves coincide closely with the measured performance curves.

Direct Measurement of Net Positive Suction Head...........58—A-38

By R. B. Jacobs and K. B. Martin, National Bureau of Standards, Boulder, Colo.; and R. J. Hardy, U. S. Naval Ordnance Laboratory, Corona, Calif. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Basic Engng.;* available to Oct. 1, 1959).

A simple, reliable, and accurate method for measuring net positive suction head is described, difficulties which may be encountered in its application are discussed, and test information indicating its reliability and accuracy is presented. The device which embodies the method consists of a vapor-pressure bulb that measures the vapor pressure of the liquid, a pressure tap that measures stagnation pressure, and a pressure gage to indicate (and record, if desired) the difference between the two pressures.

Applied Mechanics

Transverse Flexure of a Thin Plate Containing Two Circular Holes...........................58—A-35

By O. Tamate, Tohoku University, Sakurakoji, Sendai, Japan. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

The problem of finding stress resultants in a thin elastic plate containing two circular holes of equal size, under plane bending about the axes of symmetry, has been discussed on the basis of the Poisson-Kirchhoff theory. A method of perturbation is adopted for the determination of parametric coefficients involved in the solution. The factors of stress concentration are calculated and compared with the results available.

Theory of Flight of the Sounding Rocket.................58—A-32

By V. C. Liu, The University of Michigan, Ann Arbor, Mich. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

Solutions of the equations of motion of vertically ascending rockets (both in power flight and in free flight) are given in closed form. Atmospheric density is assumed to vary exponentially with altitude, and the variation of the drag coefficient of the rocket with Mach number is assumed to follow a definite pattern. (The validity of the latter assumption is established by its close agreement with measured results.) These solutions, given in terms of special transcendental functions, can be used for the rapid estimation of sounding-rocket performance, eliminating the often-used laborious process of stepwise integration. The general rocket performance parameters prescribed in the analysis also can be used to advantage in comparing and selecting multistage sounding rockets.

Normal-Vibrations of a Uniform Plate Carrying Any Number of Finite Masses..........58—A-28

By W. F. Stokey, Assoc. Mem. ASME, and C. F. Zorowski, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

A general method is presented for determining approximately the natural frequencies of the normal vibrations of a uniform plate carrying any number of finite masses. Its application depends on knowing the frequencies and natural modes of vibration of the unloaded plate and the physical characteristics of the mass loadings. A numerical example is presented in detail in which this method is applied to a simply supported plate carrying two masses. Results also are included of experimentally measured frequencies for this configuration and several additional cases along with the frequencies computed using this method for comparison.

Stresses and Deflections in an Elastically Restrained Circular Plate Under Uniform Normal Loading Over a Segment.....58—A-27

By W. A. Bassali and M. Nassif, University of Alexandria, Alexandria, Egypt. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

Within the limits of the small-deflection plate theory and using complex variable methods, an exact expression is developed in series form for the solution of the problem of a thin circular plate elastically restrained along the boundary and subjected to uniform normal loading over a segment of the plate. The elastic constraint considered includes as particular cases the rigidly clamped and simply supported boundaries. For a rigidly clamped boundary the results are expressed in finite terms. Some details of calculations of deflections, moments, and shears based on the theory are provided in tables and curves. Timoshenko's notation is used in the paper.

The Strain-Energy Expression for Thin Elastic Shells.......58—A-25

By J. H. Haywood and L. B. Wilson, Naval Construction Research Establishment, St. Leonard's Hill, Dunfermline, Fife, Scotland. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

A strain-energy expression is derived for thin isotropic elastic shells in terms of the displacements of the middle surface of the shell. This expression is confined to small deflection theory, and the condition of plane stress previously used in the theory of thin shells is retained. A simplified expression is also obtained by the introduction of the Kirchhoff-Love hypothesis, and the relative merits of these two expressions are discussed. The strain-energy expression is applied to the thin circular cylinder, and the result is compared with various strain-energy expressions previously developed.

The End Problem of Cylinders...........................58—A-24

By G. Horvay, Mem. ASME, and J. A. Mirabal, General Electric Research Laboratory, Schenectady, N. Y. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Appl. Mech.;* available to Oct. 1, 1959).

When self-equilibrating rotationally symmetric normal and shear tractions $s_k(r)$, $t_k(r)$ act on an end face of a cylinder, stresses ensue which decay with distance from the loaded end as $e^{-\alpha_k z}$, where α_k is the real part of an eigenvalue parameter γ_k. The analysis is carried out in a variational approximation; the method is based on Sadowsky-Sternberg stress functions $\Phi_k(z,r)$ which are so modified as to identically satisfy the equilibrium equations. The factors $F_k(r)$ of the functions $\Phi_k = G_k(z)F_k(r)$ or $\Phi_k = H_k(z)F_k(r)$ $(k = 2, 4, 6, \ldots)$ are polynomials of degree $k + 2$, which are orthogonal in a "generalized sense"; their appropriate derivatives constitute $s_k(r)$ and $t_k(r)$. The polynomials $s_k(r)$, $t_k(r)$, of degrees k and $k + 1$, respectively, form two complete sets of tractions in terms of which arbitrary rotationally symmetric self-equilibrating end tractions may be expanded. The factors $G_k(z)$, $H_k(z)$ of the stress functions Φ_k are exponentially decaying sinusoidals; $G_k(z)$ is appropriate for the normal load problem, $H_k(z)$ for the shear-load problem. The function Φ_2 leads, for $\nu = 0.3$, to the fundamental variational eigenvalue $\gamma_2 = 2.69 + i\,1.34$, as contrasted with the rigorous value $\gamma_2 = 2.72 + i\,1.35$.

Machine Design

Four-Bar Linkages—Approximate Synthesis.............58—A-130

By W. W. Worthley, Pratt and Whitney, Division of United Aircraft Corporation, West Palm Beach, Fla.; and R. T. Hinkle, Mem. ASME, Michigan State University, East Lansing, Mich. 1958 ASME Annual Meeting paper (in type; to be published in Trans. ASME—*J. Engng. for Indus.*; available to Oct. 1, 1959).

An analytical method for synthesizing a four-bar linkage as a function generator is presented. The method, which permits the arbitrary selection of four precision points and finite angular ranges, is based on a graphical solution. This permits a preliminary graphical investigation of the six possible linkages before selecting one for analytical treatment.

For Tools and Dies—New Epoxy-Fiber Compositions....58—A-244

By A. P. Mazzuchelli, Bakelite Company, Division of Union Carbide Corporation, New York, N. Y. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

New epoxy compositions have been developed which utilize metal-fiber reinforcement in such a manner as to extend substantially those advantages presently provided by plastic tooling to the field of metal fabricating. In this field, competition has been forcing more frequent styling changes, resulting in the introduction of more models with less production per model. Each such style change requires tooling, and with mounting costs this requirement is becoming so serious that the very life of many segments of industry is threatened by it. All of this emphasizes the great need for lower cost, faster built tooling.

By employing metal fibers as a reinforcement for heat-resistant epoxy resin systems, investigations show that reinforced castings can be made with abrasion resistance, impact strengths, heat-distortion points, and thermal conductivities greatly in excess of conventionally filled, room-temperature epoxy compositions. The improvement is such that these metal-fiber-reinforced compositions can be used for the more difficult prototype jobs and many medium-run production jobs. In addition, metal fibers bring to such structures a high degree of machinability and a control over exotherm heat which permits epoxy castings of practically unlimited size with low shrinkage.

Basically, investigation has centered around three types of reinforced, heat-resistant epoxy compositions, utilizing three types of metal-fiber reinforcement; namely, steel, aluminum, and combinations of steel and glass fibers. These fibers are incorporated into the resin and the desired tool cast by a pressure process. To obtain best performance when applying these compositions to tools and dies, a special technique was developed of flocking or spraying a face coat of short metal fibers on the pattern or mold used for fabricating the reinforced casting. Either glass or metal fibers may be used for the body of the casting; but, for best results, it has been found necessary that this face coat of chopped metal-fiber flocking be applied to the surface of the casting. In addition to being essential for satisfactory die performance, the metal fibers flocked on the surface prevent the resin face coat from sagging on corners and vertical walls of die molds.

Specifically, the three types of composition which this work indicated to be the most suitable for metal-forming dies and other tooling uses are these: A mass casting of a heat-resistant epoxy resin system reinforced with low-carbon steel fibers of continuous or varying length and surfaced with a face coat based on an epoxy resin and steel-fiber flocking; a mass casting of a heat-resistant epoxy resin system reinforced with glass fiber and surfaced with a face coat based on an epoxy resin and steel-fiber flocking, the face coat sometimes backed with a steel fiber mat; a mass casting of heat-resistant epoxy resin system reinforced with aluminum fibers and surfaced with a face coat based on an epoxy resin and aluminum-fiber flocking. In commercial use, these compositions have been designated Epoxy-Alloys ES, EG-SF, and EA, respectively.

As a result of extensive laboratory work, a great deal of information on the physical properties of these compositions and on the process principles involved in die fabrication has been obtained. The high lights of this investigation are presented in this paper.

Extension of Holzer-Myklestad-Prohl Calculation of Turbo-Rotor Critical Speeds........58—A-246

By R. L. Urban, Assoc. Mem. ASME, Armour Research Foundation of the Illinois Institute of Technology, Chicago, Ill. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

The method of calculating critical speeds of a flexible turbo rotor presented in this paper is offered as an extension of the Holzer-Myklestad-Prohl calculation in that it incorporates certain closed solutions to eliminate approximating actual rotor mass distribution, thus simplifying the analytical approach. The proposed calculation is applied to the rotor used by Prohl in his paper and by utilizing the IBM 650 digital computer, the critical speeds (first, second, and third) are determined. The effect of the gyroscopic moment due to the tilting of the disks from the vertical on the critical speeds also is included in this analysis.

Instruments and Regulators

Automatic Control in Mechanical Engineering...........58—A-295

By D. P. Eckman and Irving Lefkowitz, Case Institute of Technology, Cleveland, Ohio. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

Automatic control and instrumentation have served as one of the greatest unifying forces in the history of engineering because of the horizontal combining of the many disciplines into one engineering problem. More than ever before, the modern mechanical engineer requires an adequate background of mechanics, electricity, and heat, as well as rigorous training in modern physics and advanced mathematics.

Concurrent growth in other technical fields such as chemical kinetics and dynamics, solid state physics, nuclear power, astronautics, and operations research stress further the interdependency of many diverse disciplines. These developments point up more and more strongly the arbitrary nature of the boundaries delineating the fields of mechanical, electrical, civil, chemical, and metallurgical engineering as they exist today. It is most timely, therefore, to consider the impact of modern

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technologies and, in particular, automatic control technology on mechanical engineering.

The mechanical engineer's interest in automatic control has necessarily developed in many directions; in the field of power machines, in production processes, and even into manufacturing. Thus the mechanical engineer has the widest range of interest in instrumentation and automatic control encompassing equally power servomechanisms, process control, and data transmission and computation.

Automatic-control education is discussed in this paper. In this connection, it treats the organization of instrumentation teaching, graduate study in automatic control, research in automatic control, and industry-education co-operation.

Control Technology as a Unifying Tool in Engineering Education..... ....58—A-199

By Gerhard Reethof, Mem. ASME, General Electric Company, Cincinnati, Ohio. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

One of the most perplexing and difficult problems in engineering education is to teach the student how to apply the mathematical techniques and the information from the technical courses which he has absorbed to the solution of engineering problems. In the final analysis, the solution of these difficult problems by analysis and experiment is the real task of engineering. The problem formulation and problem solution are the aspects of the engineering activity which are of particular interest to this discussion. In this paper, the author discusses certain considerations about the unifying potential of control engineering courses in the engineering curriculum.

Generalizing the Concepts of Power Transport and Energy Ports for Systems Engineering......58—A-296

By H. M. Paynter, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1958 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

By first generalizing the concept of the Poynting vector to cover the spatially continuous flux of available energy in all forms, a wide variety of basic engineering systems may be conceived as a reticulation into "multiport" systems, at the boundaries of which power is transported only through a finite number of facets or "energy ports." Most commonly used standard components may then be cataloged into a relatively small set of primitive subsystems or "elements" in the form of one-ports, two-ports, and three-ports. ●

ASME TRANSACTIONS

The April, 1959, issue of the Transactions of the ASME—*Journal of Power* (available at $1.50 per copy to ASME Members; $3 to nonmembers)—contains the following:

Journal of ENGINEERING FOR POWER

Volume 81 • Series A • Number 2

111 The Control System of a 225,000-Kw Double-Automatic Extraction Steam Turbine and Related Reducing Stations, by M. A. Eggenberger and P. G. Ipsen. (58—SA-36)
123 Design of 321-Mw Cross-Compound Steam Turbine—River Rouge Unit No. 3, by C. D. Wilson. (58—SA-22)
133 Five Years' Experience on the Consolidated Edison System With Protection of Turbine Generators and Boilers by Automatic Tripping, by W. C. Beattie, H. A. Bauman, J. M. Driscoll, P. T. Onderdonk, and R. L. Webb. (58—Pwr-8)
142 A Simplified Regenerator Theory, by W. F. Schalkwijk. (58—A-135)
151 Development of a Smooth Running, Double-Spool, Gas-Turbine Rotor System, by J. R. Schnittger. (58—A-197)
161 M-252 Alloy for Heavy-Duty Gas-Turbine Buckets, by G. R. Fusner and D. L. Newhouse. (58—A-191)
177 The Calibration of Thermocouples by Freezing-Point Baths and Empirical Equations, by R. P. Benedict. (58—A-175)
189 Theoretical Stresses Near a Circular Opening in a Flat Plate, Reinforced With a Cylindrical Outlet, by E. O. Waters. (58—A-171)
201 Effect of Steam-Turbine Reheat on Speed-Governor Performance, by Charles Concordia. (58—A-36)
208 Load Capacity Tests on Tapered-Land and Pivoted-Shoe Thrust Bearings for Large Steam-Turbine Application, by R. E. Brandon and H. C. Bahr. (58—A-172)

Notes on
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REVIEWS OF BOOKS

Education and Freedom

Education and Freedom
By H. G. Rickover. E. P. Dutton & Company, Inc., New York, N. Y., 1959. Cloth, $5^{1}/_{4} \times 8$ in., Foreword by Edward R. Murrow; Preface by Charles Van Doren, appendixes, index, 256 pp., $3.50.

Reviewed by Frederick S. Blackall, jr.[1]

Vice-Admiral Hyman G. Rickover, in very truth the Messiah of the Atomic Age, is widely hailed as a great engineer, a fearless leader, a merciless taskmaster, and an iconoclast. But few who readily credit him with brilliance in these facets of the theoretical and applied sciences would guess that he is also a talented author and a scholarly one.

The book under review is a searching and constructive critique of the American educational process, written in a facile style, which is at times learned, but never heavy. The result is a volume of easy and intensely thought-provoking reading, the product of a sound writer and a persuasive dialectician.

The Admiral's analysis of the elementary and secondary schools of our nation recites in convincing detail the manner in which our public schools have drifted away from fundamentals to frivolities; from the development of merit to the pampering of mediocrity; from the inculcation of basic principles to the cult of "know-how" courses.

It will come as a surprise to many to find here a scientist who is appealing for the return to a liberal arts program of high quality and sound content as the only proper approach to higher learning in the professional fields and especially in engineering and science.

The author is deeply stirred by the danger which lurks in the easy pace of the American secondary-school curriculum. His is the Cassandra call of the patriot when he says that in a defense economy wholly based on technical competence and genius, our national security is threatened when we fail to develop our intellectual resources to the fullest extent. He goes on to illustrate in devastating detail how Russia and the nations of Western Europe are doing this far more effectively than we are.

The degeneration of our public schools is the result, in his view, of a misguided interpretation of the democratic principle. The superior student—and there are potentially many of these—is held back, stifled, and often frustrated in a schooling program whose tempo and subject matter are determined by the ability of the average, or even subaverage pupil. The end-result can only be a relative decline in our national I. Q. and a progressive shortage of competent technicians and professionals. It appears that we are the only one among the leading Western nations which does not differentiate in its government-supported school system between courses for the talented, and courses for the rank and file or for those who cannot cope with the educational process above the vocational level. We drag down the scholar in order to save face for the dullard, or more likely, for his parents.

"Unless we abandon false 'democratic' clichés which interpret democracy as enthronement of the commonplace and obstruction of excellence," he writes, "we may find that we have traded freedom for a mass of pseudodemocratic mediocrity.

"Technological progress is limited by availability of trained professionals and this in turn largely depends upon... superior brain power over which we have little control and development of available talent—here we can do much!"

Rickover pulls no punches in stating that if we don't promptly revise our educational methods, as England, Germany, France, and the Soviets have done, we shall stand in grave danger of losing the race with Russia.

The author says in his preface that the work is essentially an anthology of speeches. Thus a certain amount of repetition runs through the volume, but the effect, happily, is one of emphasis and re-emphasis of his great theme rather than one of mere reiteration.

The Admiral repeatedly expresses concern over the low esteem in which he feels scientists and intellectuals are held by Americans ("egg-heads"; "long-hairs"). This reviewer doubts that they are so regarded by persons worthy of an opinion. The author's point of view may be subjective; but in more than one area, I suspect that he exaggerates to make a point. The end justifies the means.

Rickover's essay on "The Meaning of a Profession: Engineering, "will strike a responsive chord in the soul of every engineer who is sickened by the loose use and abuse of the professional title by those who have not earned it. An inspired sermon on the rights, privileges, and obligations of the engineer, it deserves a permanent place in the literature of our profession. Every member of ASME should read it.

Summary: A thoroughly documented call to substitute stuff for fluff in our public schools and give the youth of the future a chance to realize its potential, thereby, perhaps, saving our nation from humiliation and even defeat. Sound argument by a distinguished engineer who proves himself to be a competent writer and an able scholar as well.

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[1] President-Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I. Past-president and Fellow ASME.

BOOKS RECEIVED IN LIBRARY

Handbook of Automation, Computation, and Control, Vol. 1: Control Fundamentals
Edited by Eugene M. Grabbe and others. 1958, John Wiley & Sons, Inc., New York, N. Y. Various pagings. $6 \times 9^{1}/_{4}$ in., bound. $17. This volume, the first in a series of three, provides information which forms a foundation for the later volumes. It covers

mathematics as applied to control, such as sets and relations, Boolean algebra, probability, and statistics. This is followed by a compilation of the latest techniques of numerical analysis, as well as comparisons of the various techniques; material on information theory, smoothing, filtering, and data transmission; thorough treatments of feedback-control theory and of operations research. Emphasis is placed on practical methods of applying the theory.

Introduction to the Design of Servomechanisms

By John L. Bower and Peter M. Schultheiss. 1958, John Wiley & Sons, Inc., New York, N. Y. 510 p., $6 \times 9\tfrac{1}{4}$ in., bound. $13. Gives a basic explanation of stability and feedback design, both single and multiple loop. The author attempts to provide a systematic approach to design problems and the principal performance requirements entailed such as harmonic response, time response, error coefficients, and noise response. Attention is also given to the common aspects of nonlinear operation, and an appendix is included which covers servomechanism components.

An Introduction to Fluid Dynamics

By G. Temple. 1958, Oxford University Press, New York, N. Y. 195 p., $5\tfrac{1}{2} \times 8\tfrac{3}{4}$ in., bound. $4. Stresses the fundamental dynamical principles and their immediate applications to the types of fluid flow actually observed or produced, particularly the "disturbance" flow created by the motion of a solid body through a fluid. A detailed description is given of the theory of irrotational motion and of velocity potential, and full use is made of functions of a complex variable in problems of plane parallel flow. A number of simple fields of flow are studied to indicate the solutions of the fundamental equations and to illustrate general hydrodynamic theorems.

Knocking Characteristics of Pure Hydrocarbons

Published 1958 as Special Technical Publication No. 225 by the American Society for Testing Materials, Philadelphia, Pa. 96 p., $8\tfrac{1}{2} \times 11\tfrac{1}{4}$ in., bound. $6. A study of a wide variety of pure hydrocarbons for the purpose of relating their structures and physical characteristics to their respective knock limitations in engines. Various engine types and operation procedures were utilized to take into account the effect of these variables on knock ratings. The study was developed under the American Petroleum Institute Hydrocarbon Research Project.

Die Kräfteermittelung in Dünnwandigen Blechkonstruktionen

By A. F. Feofanow. 1958, Technischer Verlag Herbert Cram, Berlin, Germany. 220 p., $5\tfrac{3}{4} \times 9\tfrac{1}{2}$ in., bound. DM 24. This translation from the Russian presents a highly detailed mathematical and graphical analysis of thin-shell construction, specifically of airplane structures. It covers both statically determinate and indeterminate structures, and includes a chapter on the effect of notches, cutout sections, etc.

The Metal Thorium

Edited by Harley A. Wilhelm. 1958, American Society for Metals, Cleveland, Ohio. 397 p., $6 \times 9\tfrac{1}{4}$ in., bound. $10. A collection of papers on various aspects of thorium. Topics discussed include: Production of thorium compounds; consumable-electrode arc melting; electrolytic refining; physical constants, crystal structure, and thermodynamic properties; electronic structure; mechanical properties of thorium and high-thorium alloys; fabrication and cladding; corrosion; effects of irradiation; metallography; chemical and spectrographic analysis. The papers were presented at a conference held in Cleveland in 1956.

Operational Research in Practice

Edited by Max Davies and Michel Verhulst. 1958, Pergamon Press, New York, N. Y. 201 p., $6\tfrac{1}{4} \times 10$ in., bound. $12. A report of a NATO conference on what operations research can do, and how various operations-research techniques have been applied to specific problems such as methods of air defense, systems of evaluation and military planning, logistic and transport operations, and war games. The interrelation of military and industrial operations research is brought out, and a considerable amount of the material included has application to civilian and industrial goals. Published for the Advisory Group for Aeronautical Research and Development.

Rohrhydraulik

By H. Richter. Third edition. 1958, Springer-Verlag, Berlin, Germany. 354 p., $6\tfrac{1}{2} \times 9\tfrac{1}{2}$ in., bound. DM 37.50. Entitled "pipe hydraulics," this volume constitutes a handbook of practical-flow measurements. Beginning with the basic physics, it considers both the theoretical aspects and experimental results, concluding with the practical design of steam, gas, air, oil, and water pipelines. Graphs and nomograms facilitate direct application of the information given.

Sampled-Data Control Systems

By John R. Ragazzini and Gene F. Franklin. 1958, McGraw-Hill Book Company, New York, N. Y. 331 p., $6\tfrac{1}{4} \times 9\tfrac{1}{4}$ in., bound. $9.50. Presents the analysis and design of sampled-data feedback and control systems. Sampled-data theory is developed and serves as a base for the analysis and synthesis of linear digital systems, pulsed continuous systems, and their combinations found in practice. In addition, the subject is broadly treated to include applications in the fields of communications, data processing, and filtering. A particular feature is the discussion on the use of digital computers as in-line controllers.

The Shippingport Pressurized Water Reactor

By the U. S. Atomic Energy Comm., Division of Reactor Development, Naval Reactors Branch. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 588 p., $6\tfrac{1}{2} \times 9\tfrac{1}{2}$ in., bound. $9.50. All aspects of the design and construction of the Shippingport reactor are discussed. Among the topics included are the factors entering into the selection of plant-design parameters; reactor design, fuel-element development, and core construction; radioactive waste-disposal system; electrical and mechanical components used in the reactor plant; shieldings of the reactor plant and waste-disposal facilities; hazards evaluation; a description of the turbine-generator plant; training of personnel. A volume in the Atoms for Peace presentation set.

Sodium Graphite Reactors

By Chauncey Starr and Robert W. Dickinson. 1958, Addison-Wesley Publishing Co., Inc., Reading, Mass. 288 p., $6\tfrac{1}{2} \times 9\tfrac{1}{2}$ in., bound. $6.50. Placing emphasis on the Sodium Reactor Experiment (SRE), such aspects are covered as the reactor and its shielding, cooling, and fuel-handling systems; nuclear, heat-transfer, and transient characteristics; design and development of components; installation of equipment and operation of the plant. In addition, information of a general nature is included dealing with the origin of the sodium-graphite concept, the technologies of sodium, graphite, and zirconium as they relate to sodium-graphite reactor design, and fuel-element development. A volume in the Atoms for Peace presentation set.

Solid Propellant Rockets; an Introductory Handbook: Second Stage

By Alfred J. Zaehringer. 1958, American Rocket Company. Box 1112, Wyandotte, Mich. 306 p., $5\tfrac{1}{2} \times 8\tfrac{3}{4}$ in., bound. $8. This edition contains additional chapters covering new developments and recently declassified information, including new applications, propellant technology, hybrid rockets, and safety. A particular feature of the volume is the extensive bibliography of over 800 items dealing with solid propellants.

Technical Drawing

By Frederick E. Giesecke and others. Fourth edition. Macmillan Company, New York, N. Y. 844 p., $7 \times 10\tfrac{1}{4}$ in., bound. $10. A thorough revision of a well-known text. Areas which have been given particular attention in this edition include geometrical constructions; dimensioning and notes; threads, fasteners, and springs; shop processes; engineering graphics; structural drawing; topographic drawing; welding representation. The majority of the illustrations have been redrawn, and the format of the book has been enlarged to permit clearer illustrations. The entire volume has been revised to reflect the latest American Standards.

Thermodynamic Properties of Water and Steam

By M. P. Vukalovitch. Sixth edition. 1958, VEB Verlag Technik, Berlin, Germany. 245 p., $8\tfrac{1}{2} \times 11\tfrac{3}{4}$ in., DM 20. Following preliminary material on the association theory of real gases, superheated steam, and the thermodynamic relations for dry saturated steam and boiling water, tables are given for the thermodynamic properties of water and steam up to pressures of 800 to 1000 and temperatures of 1000 C. In setting up the tables for the high temperatures, the authors have extrapolated certain values from the experimental data available. The book is in four languages, English, French, Russian, and German printed in adjoining columns.

Transform Method in Linear System Analysis

By John A. Aseltine. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 300 p., $6\tfrac{1}{4} \times 9\tfrac{1}{4}$ in., bound. $8.50. Special emphasis is placed throughout on the ways in which the use of integral transformations can unify the methods of system analysis through the concept of the system function. The first half of the book deals with the Laplace transform and its application to problems in electricity and mechanics. This is followed by Fourier transforms and their application to problems involving noise. In conclusion, the Mellin transform is introduced as a method suitable for the solution of a class of variable-coefficient equations.

Transistor Technology, Vol. III

Edited by F. J. Biondi. 1958, D. Van Nostrand Company, Inc., Princeton, N. J. 416 p., $6\tfrac{1}{4} \times 9\tfrac{1}{4}$ in., bound. $12.50. This, the last volume of an extensive work, deals with the preparation of junctions; fabrication technology, including such processes as etching, alloying and diffusion, photoengraving techniques, and procedures for making contacts; information on measurement and characterization; laboratory and field-use reliability. The material is equally divided between that of a general nature and that which is specific to germanium and silicon.

The Transuranium Elements

By Glenn T. Seaborg. 1958, Addison-Wesley

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Publishing Co., Inc., Reading, Mass. 328 p., $6^{1}/_{2} \times 9^{1}/_{2}$ in., bound. $7. The author begins with the discovery of plutonium in 1940 as the result of the bombardment of natural uranium with deuterons in a cyclotron. He then discusses the chemical properties of the actinide elements, ranging from thorium to Mendelevium. The concluding portions of the book are concerned with the nuclear properties of the transuranium elements and the possibilities for new elements. A volume in the Atoms for Peace presentation set.

Analog Simulation
By Walter J. Karplus. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 434 p., $6^{1}/_{4} \times 9^{1}/_{4}$ in., bound. $10. Gives a comprehensive survey of analog techniques and systems for solving field problems. The first part deals with the mathematical principles and techniques of immediate and direct interest in solving partial differential equations by electric analogs. This is followed by a comprehensive study of the various methods of simulating field problems by analogs. The basic operation of each system is described in some detail along with auxiliary techniques found useful. The concluding section is concerned with the solution of typical engineering problems.

Automatic Measurement of Quality in Process Plants
Published 1958 for the Society of Instrument Technology by Academic Press, Inc., New York, N. Y. 320 p., $5^{3}/_{4} \times 8^{3}/_{4}$ in., bound. $9.50. Papers covering two aspects of the field: those that survey the experience gained with the control instruments now in use, and those that explore the potential plant application of analytical techniques currently used only in the laboratory. Specific topics include techniques for gas-stream analysis, spectrometric methods, liquid-stream analysis, new techniques for fluid-stream analysis, and measurement of various physical properties.

Compact Heat Exchangers
By W. M. Kays and A. L. London. 1958, McGraw-Hill Book Company, New York, N. Y. 156 p., $8^{1}/_{2} \times 11^{1}/_{4}$ in., bound. $6.50. A comprehensive treatment of compact heat-transfer surfaces, including tube banks, plate fin surfaces, finned tube surfaces, and screen and sphere matrix surfaces. Analytical solutions are considered for abrupt contraction and expansion pressure-loss coefficients, laminar-flow heat transfer in circular and rectangular tubes, and the effects of temperature-dependent field properties on heat transfer and flow friction. A chapter is devoted to heat-exchanger performance theory, developed around the effectiveness versus number of heat-transfer units. Use of the data and theory is illustrated by sample problems.

Creative Thinking
By Charles S. Whiting. 1958, Reinhold Publishing Corporation, New York, N. Y. 168 p., $5 \times 7^{1}/_{2}$ in., bound. $3.95. The major portion of the book is concerned with operational techniques of creative thinking, including group discussion methods and analytical or mechanical techniques that groups have found useful in stimulating new ideas. Among those methods presented are the Gordon technique and programs used by various corporations.

Elements of Engineering Statics
By H. Deresiewicz. 1958, Columbia University Press, New York, N. Y. 124 p., $6 \times 9^{1}/_{4}$ in., bound. $3.50. Covers the problem of equilibrium, equilibrium of simple planar systems, equivalence of force systems, simple structures, sliding friction, work and energy methods, and equilibrium of simple spatial systems. The techniques of vector algebra are employed to develop rigorously the fundamental theorems, results, and methods of statics and to apply these to the solution of engineering problems. An extensive appendix consists of problems to illustrate the principles of the text.

Introduction to the Theoretical and Experimental Analysis of Stress and Strain
By A. J. Durelli and others. 1958, McGraw-Hill Book Company, Inc., New York, N. Y. 498 p., $6^{1}/_{4} \times 9^{1}/_{4}$ in., bound. $12.50. An introduction to the field of stress analysis that covers the theory of elasticity, dimensional analysis, mechanical strain gages, brittle coatings, and grid methods. The theory of elasticity is presented from the general three-dimensional point of view, and although the conventional parallelopiped approach is used, a rigorous theoretical development is given where necessary. Technical detail has been de-emphasized in favor of basic concepts.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

The Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in Mechanical Engineering.

(The following Case Interpretations were formulated at the Committee meeting Jan. 9, 1958, and approved by the Board on March 5, 1958.)

Annulment of Cases

Case No.	Reasons for Annulment
1166	Essence of Case included in Part UF, revised
1134	Replaced by Case No. 1262
1201	To be annulled, July 1, 1959. See Provisions of Par. UG-11(*c*) of Section VIII, Jan. 25, 1958, Addenda
1217	Stress values are included in Table UNF-23
1219	Stress values are included in Table UNF-23
1220	Stress values are included in Table UNF-23
1240	Now covered by revision to Par. UG-9

Proposed Case No. 1257

(Special Ruling)

(Use of Nickel for Jacketed Kettles)

Inquiry: When the inner shell of a jacketed kettle is constructed of nickel sheet or plate meeting the requirements of Specification SB-162, that has been work-hardened by a planishing operation, with corresponding increase in strength against collapse, what methods can be employed for determining the allowable working pressure of the inner shell? The external pressure vessel chart in Section VIII of the Code is for material in the annealed condition and does not represent the work-hardened material.

Reply: It is the opinion of the Committee that kettles such as described in the Inquiry that have the inner shell constructed of nickel (SB-162) that has been work-hardened over its entire surface during fabrication will meet the requirements of Section VIII of the Code, provided the following additional provisions are complied with:

(1) The maximum size of any vessel shall be eight feet inside diameter.

(2) The maximum operating temperature shall not exceed 400 deg F.

(3) Any butt welds that are subject to the external pressure shall be ground flush with the base metal, and the deposited weld metal and the heat affected zone be work-hardened in the same manner as the base metal.

(4) Any cylindrical skirt (flange) on a hemispherical head that is subject to external pressure shall be designed as a cylinder.

(5) The thickness of the inner shell of each vessel shall be such as to withstand without failure a hydrostatic test pressure in the jacket space of not less than three times the desired maximum allowable working pressure.

(6) In no case shall the thickness of the inner shell or head be less than that determined from the chart in Fig. UNF-28.21.

(7) The required moment of inertia of stiffening rings shall be determined from the appropriate chart in Section VIII of the Code for the material used for the rings.

(8) The outer shell and head shall be designed for increased strength, if necessary, to accommodate the test pressure specified in (5), in order to avoid rejection of the vessel under Par. UG-99(d) (Addenda of July 1, 1958).

Case No. 1260

(Special Ruling)

(Use of Clad Steels in Nuclear Reactor Vessels)

Inquiry: Reactor vessels and primary vessels for nuclear service frequently require that the surface exposed to the fluid under pressure be clad with a material having better corrosion resistance than the base metal. When intended to comply with Section I or Section VIII and with Code Case 1234, may the existing rules of Part UCL of Section VIII be used, together with the applicable design formulas from Section I or Section VIII for thickness of pressure parts?

Reply: It is the opinion of the Committee that for such vessels the rules of Part UCL of Section VIII governing application of cladding shall apply except as modified below, and that the applicable design formulas from Section I or Section VIII may be used with the following supplementary rule: The specified nominal thickness of the cladding shall not be included as a part of the required wall thickness. In applying the design formula the diameter shall be taken as the inside diameter plus twice the specified nominal thickness of the cladding.

Case No. 1261

(Special Ruling)

(Use of Aluminum Alloy GM31A (5454))

Inquiry: May aluminum alloy GM31A, which has the following chemical composition, be used in the construction of fusion-welded unfired pressure vessels under Section VIII of the ASME Code?

	PER CENT
Magnesium	2.4–3.0
Chromium	0.05–0.20
Copper, max	0.10
Manganese	0.50–1.0
Zinc, max	0.25
Titanium, max	0.20
Iron plus Silicon, max	0.40
Other, each, max	0.05
Other, total, max	0.15
Aluminum	Remainder

Reply: It is the opinion of the Committee that unfired pressure vessels using aluminum alloy GM31A, described in the Inquiry, will meet the intent of the ASME Code provided the following special provisions are followed in addition to the applicable rules of Section VIII for the design, fabrication and inspection:

(1) Sheet and plate shall meet the applicable requirements of Specification SB-209.

(2) Rods, bars and shapes shall meet the applicable requirements of Specification SB-211, SB-221, or SB-308.

(3) Pipe and tube shall meet the applicable requirements of Specification SB-235 or SB-241.

(4) The mechanical properties determined in accordance with the applicable specification shall be not less than those given in Table 1.

(5) Fabrication shall be by fusion welding. The filler metal may be of Classification F22 or the composition of the parent metal with maximum beryllium content of 0.0005 per cent and minimum titanium content of 0.05 per cent.

(6) The welding requirements and applicable paragraphs of Section IX shall apply with the following additional requirements:

(a) The base material is assigned to classification P-22.

(b) The filler material may be of the same composition as the base metal with a maximum beryllium content of 0.0005 per cent which shall be assigned to classification F-22, or the filler material may be ASTM 285-54T.

(c) The tensile strength of the reduced-section tensile specimens shall be not less than 31000 psi.

(7) The maximum allowable stress values shown in Table 2 shall be used in applying the design formulas where reference is made to Table UNF-22.

In the design of fusion-welded joints, the allowable stress values for the annealed condition shall be used.

(8) Since this alloy does not undergo a marked drop in impact resistance at low temperatures, no additional requirements are specified for temperatures down to −325° F.

(9) Bolting materials conform to an aluminum alloy listed in Table UNF-23 or one of the grades of austenitic steel of Specification SA-193. The bolting materials shall not be welded. The allowable stress values in Tables UNF-23 and UHA-23 shall apply.

(10) In addition to the material de-

TABLE 1—CASE 1261

Product	Condition	Thickness, In.	Tensile Strength, psi	Yield Strength 0.2 per cent offset, psi	Elongation in 2 in., per cent
Sheet and Plate	Annealed	—	31000	12000	14
	H112	0.250–0.499	32000	18000	8
		0.500–2.000	31000	12000	11
	H32	—	36000	26000	8
	H34	—	39000	29000	6
Rods, Bars and Shapes	Annealed		31000	12000	14
	H112	—	31000	12000	12
	H311	—	31000	16000	8
Pipe and Tube	Annealed		31000	12000	12*
	H112	—	31000	12000	10*

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* In 2 in. or in 4D.

TABLE 2—CASE 1261

	Metal Temp Not Exceeding Deg F						
Condition	100	150	200	250	300	350	400
Annealed, H112, H311	7750	7750	7700	7200	5500	4300	3500
H32	9000	9000	8800	7500	5500	4300	3500
H34	9750	9750	9250	7500	5500	4300	3500

scribed herein, any of the aluminum alloys for which allowable stress values for welded construction are given in Table UNF-23, or in a Case, may be used for appurtenances and other attachments. These parts and their connections shall be designed in accordance with the lower of the stress values in Par. 7 above and the applicable value in Table UNF-23. The welding process for the connections shall be qualified in accordance with the applicable rules of Section IX except, that the strength of the reduced-section tensile specimen shall be not less than the lower of the qualification requirements of the two materials.

(11) Cylindrical and spherical shells for external pressure and formed heads with the pressure on the convex side shall be designed by the rules of Section VIII and Chart UNF-28.13.

Case No. 1262

(Special Ruling)

(Forged Unfired Pressure Vessels)

Inquiry: May seamless steel tubing or forgings conforming to Specification SA-372, Class V, having the chemical requirements listed for additional Types E and F in Table 1, be used in the construction of forged unfired pressure vessels?

Specification SA-372 requires material under Class V to meet the tensile properties listed as Line A in Table II. Wall thickness, ability to quench from one or both sides, and the level of carbon content within the specified range may change these properties. Under these circumstances may the modified tensile properties listed as Line B in Table 2 for Class V materials including Types E and F be used in the construction of forged unfired pressure vessels?

TABLE 2—CHEMICAL REQUIREMENTS—CLASS V

Line No.	Tensile Strength Min psi	Yield Strength Min psi	Elongation Min in 2 in.
A	120,000	70,000	18 per cent
B	100,000	70,000	18 per cent

Reply: It is the opinion of the committee that these materials may be used for the construction of unfired pressure vessels to operate between −20 F and +200 F at a maximum stress value of one-fourth of the specified minimum tensile strength and that the vessels may be stamped with the code symbol provided the following requirements are met.

(1) Material Types E and F shall be manufactured and tested in accordance with Specification SA-372, Class V.

(2) Material conforming to the tensile requirements of Line B in Table II shall meet all other requirements for Specification SA-372, Class V.

(3) Vessels shall comply in all other respects with Part UF of Section VIII of the Code including the requirements for liquid quenched and tempered materials.

TABLE 1—CHEMICAL REQUIREMENTS—CLASS V

	Type E		Type F	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Carbon	.36/.44	.33/.47	.38/.46	.35/.49
Manganese	.70/1.00	.65/1.05	.70/1.00	.65/1.05
Phosphorus, max	.04	.05	.04	.05
Sulfur, max	.04	.05	.04	.05
Silicon	.15/.35	.13/.37	.15/.35	.13/.37
Chromium	.80/1.15	.74/1.21	.80/1.15	.74/1.21
Molybdenum	.15/.25	.12/.28	.15/.25	.12/.28

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Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

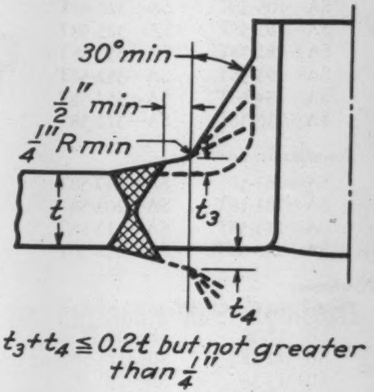
In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1956

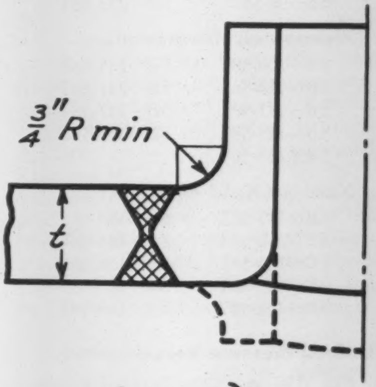
PAR. P-268(b)(1)(a) *Shape of Openings*[2] Revise the first two sentences to read:

Openings in cylindrical portions of vessels, or in formed heads, shall preferably be circular, but if not circular shall be elliptical or obround.[3]

FIG. P-36 *Some Acceptable Types of Welded Nozzles and Other Connections to Shells, Drums and Headers* Add the following sketches as q-3 and q-4.



(q-3)



(q-4)

Material Specifications, 1956

The Boiler and Pressure Vessel Committee has approved adding to Section II the following revisions to specifications and new specifications.

Ferrous

Ferritic Plates

SA—7-58T
SA—113-58
SA—283-58
SA—300-58
SA—353-58
SA—414-58T

Ferritic Tubular Products

SA—53-58aT
SA—83-58T
SA—106-58T
SA—135-58T
SA—178-58T
SA—179-58T
SA—192-58T
SA—199-58T
SA—209-58T
SA—210-58T
SA—213-58T
SA—214-58T
SA—226-58T
SA—250-58T
SA—333-58T
SA—334-58T
SA—423-58T

Ferritic Castings and Forgings

SA—29-58T
SA—48T
SA—105-58T
SA—181-58T
SA—182-58T
SA—193-58T
SA—194-58T
SA—216-58T
SA—217-58T
SA—307-58T
SA—320-58T
SA—325-58T
SA—350-58T
SA—352-58T
SA—354-58T
SA—372-58

Stainless Steels

SA—167-58
SA—182-58T
SA—213-58T
SA—240-58T
SA—249-58T
SA—268-58
SA—312-58T
SA—351-58T

Nonferrous

Copper and Copper Alloys

SB—11-58
SB—12-58
SB—13-58
SB—42-58
SB—43-58
SB—75-58
SB—96-58
SB—98-58
SB—111-58
SB—150-58
SB—152-58
SB—171-58
SB—315-58T
SB—249-58T

Aluminum and Aluminum Alloys

SB—209-58T
SB—210-58T
SB—211-58T
SB—221-58T
SB—234-58T
SB—235-58T
SB—241-58T
SB—247-58T
SB—308-58T

Nickel and Nickel Alloys

SB—127-58T
SB—160-58T
SB—161-58T
SB—162-58T
SB—163-58T
SB—164-58T
SB—165-58T
SB—166-58T
SB—167-58T
SB—168-58T

Unfired Pressure Vessels, 1956

Par. UG-36(a)(1) *Shape of Openings*[3] Revise the first two sentences to read:

Openings in cylindrical or conical portions of vessels, or in formed heads, shall preferably be circular but if not circular shall be elliptical or obround.[4]

Par. UNF-16(b) *Minimum Thickness of Plate* Add the following as a last sentence:

There is no specified minimum thickness requirement for brazed construction except that the thickness used must meet the brazing qualification requirements of Section IX, Part C.

The following charts have been adopted. A copy for comment may be obtained from the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.:

Fig. UHA-28.3 Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Austenitic Steel (18 Cr-8Ni-0.03 Maximum Carbon, Type 304L);

Fig. UHA-28.4 Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed of Austenitic Steels (18 Cr-8 Ni + Mo-0.03 Maximum Carbon, Types 316L & 317L);

Fig. UNF-28.19 Chart for Determining Shell Thickness of Cylindrical and Spherical Vessels Under External Pressure When Constructed From Aluminum Alloy GM40A-O or GM40A-H112.

Fig. UW-16.1 *Sone Acceptable Types of Welded Nozzles and Other Connections to Shells, Drums, and Headers* Add the sketches q-3 and q-4, (as given in Fig. P-36 above)

Table UNF-23 *Aluminum and Aluminum Alloy Products* Add the materials and stress values included under Additions to Table UNF-23.

Correction

In the April, 1959, issue of Mechanical Engineering, we made an error of omission that we wish to correct before we are flooded with a thousand and one queries. We published a review by W. H. Larkin of "How to Become a Professional Engineer," written by John D. Constance. We did just fine with the whole job—but we omitted the name of the author of the book. If our readers have experienced any inconvenience when trying to purchase the book, we are sorry. The author again so no one will forget—is John D. Constance.

Welding Qualifications, 1956

Par. Q-20 and QN-20 Add the following as a new paragraph:

(d) Each qualified welder and welding operator shall be assigned an identifying number, letter or symbol by the manufacturer which shall be used to identify the work of that welder or welding operator.

Table Q-11.1 Delete SB-209, Alloy GM51A (5.1 MG-0.8 Mn-0.10 Cr)—Sheet and Plate from P-Number 24 and add under new designation P-Number 25.

Figs. Q-8 and QN-8 Add the following paragraph to the *Note:*

The thickness of the 3/8-in. specimen may be used for P-25 materials with the following modifications to the dimensions of the plunger and die:
Dimension A-$2^1/_2$ in.: Dimension B-$1^1/_4$ in.:
Dimension C-$3^3/_8$ in.: Dimension D-$1^{11}/_{16}$ in.:

Figs. Q-8.1 and QN-8.1, *Note 6* Add the new paragraph as given in Figs. Q-8 and QN-8. ●

ADDITIONS TO TABLE UNF-23

Specification Number	Alloy Designation ASTM	ASA	Temper	Specified Tensile Str psi	Minimum Yield Str psi	Notes	For Metal Temp Not Exceeding Deg F	
							100	150
SHEET AND PLATE								
SB-209	GM40A	5086	O	35000	14000	(9)	8700	8700
			H112	35000	14000	(1)(9)(11)	8700	8700
			H32	40000	28000	(1)(9)	10000	9900
			H34	44000	34000	(1)(9)	11000	10800
SB-209	GM41A	5083	O	40000	18000	(9)(10)	10000	10000
			O	38000	16000	(9)	9500	9500
			H113	44000	31000	(1)(9)	11000	11000
SB-209	GM51A	5456	O	42000	19000	(9)	10500	10400
			H321	44000	33000	(1)(9)	11000	10900
BARS, RODS AND SHAPES								
SB-221	GM41A	5083	O	38000	16000	(9)	9500	9500
			H112	40000	24000	(1)(9)	10000	10000
SB-221	GM51A	5456	O	42000	19000	(9)	10500	10400
			H112	42000	19000	(9)	10500	10400
			H311	42000	25000	(9)	10500	10400
PIPE AND TUBE								
SB-210	GM51A	5456	O	42000	19000	(9)	10500	10400
			H112	42000	19000	(9)	10500	10400
			H113	42000	25000	(9)	10500	10400

Current
Engineering:
Events, News, and
Comment

E S NEWMAN
News Editor

THE ROUNDUP

EJC-AIA Establish Joint Committee to Offer Common Forum for Engineers and Architects

On Jan. 16, 1957, the Engineers Joint Council Board accepted the Planning Committee's recommendations to invite the American Institute of Architects to participate in establishing a Joint Committee to analyze and solve problems of common interest to both the engineering and architectural professions. The EJC invitation was accepted in principle by AIA on May 1, 1957, but action was delayed until the end of 1957 because of the AIA Centennial. The NSPE was advised of the EJC recommendation and an invitation was extended to them to participate.

An exploratory meeting of EJC and AIA representatives was held Jan. 9, 1958. The EJC Secretary stated the EJC members representing ASCE and ASME had recommended an effort be made to establish a single joint committee to further develop and maintain appropriate relationships between engineers and architects, and the meeting was called to determine the most suitable structure for such a joint committee. Those attending the meeting felt an independent Joint Committee should be formed with work in specific areas being handled by subcommittees reporting to the Joint Committee. Further, the members of the subcommittees would report and discuss the trend of developments of their assignments with their respective societies so a completed subcommittee report would more adequately reflect the considered thinking of the participating societies. Such a procedure would insure that when a subcommittee report is accepted by the Joint Committee and then presented to the sponsoring societies for acceptance, the latter will have been previously advised of the nature of the subcommittee's report and, therefore, be in a better position to judge its merits.

Prior to and subsequent to the Jan. 9, 1958, exploratory meeting, the following appointments to the Joint Committee were made by the interested engineering societies and the AIA: C. H. Topping, ASCE; H. A. Naylor, Jr., ASME; C. I. Maust, AIEE; J. E. Haines, ASHAE; W. F. Moehlman, NSPE; W. W. Eshbach, R. F. Larson, and A. R. Winter, AIA; E. P. Lange, EJC Secretary; and E. B. Morris, Jr., AIA Secretary.

The Joint Committee met on Sept. 5, 1958. It agreed to operate under the co-chairmanship of both engineering and architectural representatives and to meet on a quarterly basis. The Joint Committee named C. H. Topping and R. F. Larson co-chairmen. The Joint Committee also discussed the objectives and principles of the work it was undertaking. The Joint Committee again met on Dec. 3, 1958, and March 6, 1959. It has adopted the following objectives and purpose:

Objective—To maintain and further develop proper relations between engineers and architects. To co-operate on problems of national scope which are of mutual interest to the American Institute of Architects and the Engineers Joint Council, as well as other groups, in areas such as design, site planning, construction, and matters of interprofessional interest.

Purpose—To improve the relationship, co-operation, and joint functioning of engineers and architects and to raise engineering and architectural standards with respect to service to the public and quality of product; and further:

1 To develop a sincere spirit of co-operation among professions.

2 To encourage each profession to recognize the competence of each other profession to handle all stages of its respective work and business, and the paramount necessity that each profession be allowed to perform its function without unwarranted pressure or encroachment by any other profession.

3 To encourage each profession to recognize the right and privilege of another profession to assume the over-all administration and direction of all phases of a project, if that profession is so qualified.

4 To investigate all phases of individual and joint practice in design, site planning, construction, education, registration, standards of practice, division of responsibility, professional liability, legislative problems, public relations, and other matters.

Currently the Joint Committee has five Subcommittees at work, each under the direction of a member of the Joint Committee. Four Subcommittees have started to work their assignments and one Subcommittee has already developed preliminary material.

The Subcommittee on Professional Liability is chaired by W. W. Eshbach, AIA. The ASME member is J. K. M. Pryke of the Professional Practice Committee of the Society. The Subcommittee will define the problems of professional liability which concern architects and engineers and will outline a program of action.

The Subcommittee on Division of Responsibility is chaired by H. A. Naylor, Jr., ASME and vice-chairman of the Professional Practice Committee of the Society. The Subcommittee will revise the May, 1954, publication "Division of Responsibility Among the Design Professions" to include emphasis on engineering fields such as mechanical, electrical, industrial, heavy construction (highways, bridges, airports, and the like) and sanitary, as well as the urban renewal field.

The Subcommittee on Local Collaboration is chaired by A. R. Winter, AIA. J. M. Todd, past-president of ASME, has been designated by the Professional Practice Committee as the Society's representative. The Subcommittee will investigate the major problems encountered in all types of construction, as well as the question of collaboration between architects and engineers who have common interests in such projects.

The Subcommittee on Fees is chaired by C. I. Maust, AIEE. The ASME representative is G. I. Ross of the Professional Practice Committee of the Society, who, incidentally, is also chairman of the PPC Subcommittee revising the Society's "Manual of Consulting Practice for Mechanical Engineers." The Subcommittee will investigate the need for clarification of existing fee practices and establishment of principles relating to them, as well as an educational program in order to establish an equitable fee system.

In addition to the work of the Subcommittee, the Joint Committee has had under discussion a variety of items such as the AIA Allied Professions Medal, articles in *Consulting Engineering*, resolutions before the American Association of State Highway Officials, reports on the ASHAE-AIA Committee's technical work (which Committee was created prior to the development of the Joint Committee), collaboration and exchange of information with foreign professional societies and organizations, competition for professional services in urban renewal programs, and so on.

The Joint Committee will welcome suggestions or comment as to its work from the membership of ASME. Such should be sent to H. A. Naylor, Jr., 2 West Preston Street, Baltimore 1, Md.

Mysteries of the Undiscovered Earth Basis of Conference

"THE UNDISCOVERED EARTH" is the theme of a conference to be held in Birmingham, Ala., June 11–12, 1959, under sponsorship of Southern Research Institute. The conference will focus attention on the fact that the earth's relatively thin crust is virtually unexplored.

Many of the nation's foremost scientists will address the conference. A. B. Kinzel, past-president AIME and director, Union Carbide Corporation; Edward Teller, director, University of California, Radiation Laboratory; Gordon G. Lill, Geophysics Branch, Office of Naval Research; and M. King Hubbert, chief consultant in general geology, Shell Development Company, are among the speakers.

"Project Plowshare," the name given to a vast experimental program involving underground nuclear explosions, will be treated by Dr. Teller. The project offers a possible means of freeing immense oil and mineral reserves that are presently unobtainable; it may enable us to have underground power sources, control our weather, and accomplish other equally enormous tasks.

"The Deep Hole Project" will be described by Dr. Lill. This project proposes to bore through the earth's crust (below the ocean floor) and into the unknown area beneath, which is known as "Moho."

New horizons opened by the International Geophysical Year, energy sources for the next 50 years, tapping the earth, water for an expanding world, and resources of the ocean are among other topics to be discussed.

"The Undiscovered Earth" is one of a series of conferences held annually by Southern Research Institute. The Institute's May, 1957, conference, which took place several months prior to the launching of the first sputnik, was titled "The Age of Space."

1959 Material Handling Institute Exposition, Cleveland, June 9–12

THE 1959 Material Handling Institute Exposition will be held June 9 through 12 at the Cleveland (Ohio) Public Auditorium. A technical program is scheduled to be held in conjunction with the exposition.

"Breakthrough" is the central theme for these technical sessions. Papers will relate to breaking through material-handling costs, to lower production expenses, and increased profits. A secondary theme will cover: Management, sponsored by the Society for Advancement of Management; Engineering, The American Society of Mechanical Engineers; and Application Techniques, American Material Handling Society.

The ASME program—Engineering—is as follows: "Mechanized Freight Handling at Railroad Terminals," a paper by M. A. Michel; and "Some System Design Considerations in Containerizing Ships' Cargoes," by Foster Weldon will be presented at the first session with A. T. Gaudreau serving as chairman. At the second ASME session Prof. Bron Saunders, Cornell University, will preside and the following papers will be presented: "Coal Handling Facilities at a Power Generating Station," by John Moskowitz and William O'Grady; and "An Engineered Case Handling System in a Modernized Brewery," by G. E. Waldron.

MEETINGS OF OTHER SOCIETIES

May 18–19

Society of American Military Engineers, national convention, Washington, D. C.

May 20–22

Society for Experimental Stress Analysis, spring meeting, Sheraton-Park Hotel, Washington, D. C.

May 24–27

ARS, IAS, ISA, AIEE, national telemetering conference, Cosmopolitan Hotel, Denver, Colo.

May 25–27

American Society for Quality Control, annual meeting, Cleveland Hotel, Cleveland, Ohio

May 25–28

Design Engineering Show, Convention Hall, Philadelphia, Pa.

June 4–7

Society of Women Engineers, national convention, Chase Hotel, St. Louis, Mo.

June 8–10

Engineering Institute of Canada, annual meeting, Royal York Hotel, Toronto, Ont., Canada

June 8–11

American Rocket Society, semi-annual meeting, El Cortez Hotel, San Diego, Calif.

June 8–12

National Bureau of Standards, national conference on weights and measures, Sheraton-Park Hotel, Washington, D. C.

June 12–15

Society of Naval Architects and Marine Engineers, spring meeting, *T.S.S. Tadoussac*, on the St. Lawrence Seaway.

June 14–19

Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 17–20

National Society of Professional Engineers and N. Y. State Society of Professional Engineers, engineering exposition, Hotel Commodore, New York, N. Y.

(*For ASME Coming Events, see page 130*)

COMING MEETINGS

Analysis Instrumentation

ADVANCES in analysis instrumentation applying to several branches of science and at least six industries will be highlighted at the Fifth National Symposium on Instrumental Methods of Analysis sponsored by the Instrument Society of America, May 18–20. The Hotel Shamrock Hilton, Houston, Texas, will be the symposium site.

Many of the 30 symposium papers, although delivered primarily by authorities from chemical and petroleum companies, will apply to investigations in medicine and other sciences and to research and process development in the food, nuclear, rubber, and plastics industries.

Human Engineering

A four-day program, May 19–22, dealing with human capabilities and limitations as they relate to the design of complex man-machine systems, specific equipment items, consumer products, and workplaces, is scheduled for the Seventh Annual Human Engineering Institute sessions.

The Institute is sponsored by Dunlap and Associates, Inc., Stamford, Conn. Lectures and discussions will concentrate on basic concepts and newest techniques.

Registrations for the course are now being accepted. The fee of $275 includes texts, handbooks, and other technical material. Address requests for further information to: R. T. Eckenrode, Director, Seventh Annual Human Engineering Institute, Dunlap and Associates, Inc., 429 Atlantic Street, Stamford, Conn.

World Petroleum Congress

The Fifth World Petroleum Congress and Exposition will be held June 1–5, at the Coliseum, New York, N. Y. More than 200 exhibits from the United States and many foreign countries will be on view.

The exposition will gesture new mechanical applications of the most recent technology in exploration, prospecting, development, and the many field operations incident to production, refining, and manufacture of petroleum derivatives.

Technical sessions at which 285 papers will be presented will cover petroleum science from geology and geophysics to the applications of atomic energy to the petroleum industry.

ASA to Study Practical Value of Reaffirming American Standard for Inch-Millimeter Conversion

Recently announced International Inch, effective July 1, 1959, motivated study

The Miscellaneous Standards Board of the American Standards Association has recommended that a special committee be set up to study the practical value of reaffirming the American Standard for inch-millimeter conversion based on the factor of one inch = 25.4 millimeters.

This action was the result of the recent announcement of the standards laboratories of Australia, Canada, New Zealand, South Africa, United Kingdom, and the United States to the effect that, as from July 1, 1959, the legal inch to be used in these countries will be standardized to measure exactly 25.4 millimeters. Until now, three different legal inches have been in use: The United States legal inch—25.400051 millimeters; the Imperial inch—25.399956 millimeters; and the Canadian inch (since 1951)—25.4 millimeters.

The American Standard Practice for Inch-Millimeter Conversion for Industrial Use (B48.1-1933), based on the conversion factor of 25.4 millimeters = one inch, was first approved as an American Standard in 1933. It was reaffirmed in 1947. To insure statistical accuracy in the use of this conversion factor, American Standard Rules for Rounding Off Numerical Values (Z25.1-1940) were developed and approved as an American Standard in 1940.

Because of the legalization of the 25.4-millimeter inch, the ASA proposed committee will have to decide whether to let the two standards lapse or to recommend their reaffirmation for the convenience of industrial users. Comments from all national groups interested in this matter are invited by ASA.

The following offers background information on the two standards involved:

B48.1-1933—American Standard Practice for Inch-Millimeter Conversion for Industrial Use.

In 1932, ASA was requested to submit to American industry the question whether the inch for industrial use should be standardized to measure exactly 25.4 millimeters rather than 25.400051 millimeters, which was the legal length in the United States. Among the reasons given in support of the proposal were the facts that the ratio of 25.4:1 had already been used widely by industry, and that the use of the American legal factor, which differed again from the British legal factor, was awkward and costly.

The ASA referred the request to a special committee composed of representatives from the following organizations: Society of Automotive Engineers, National Electrical Manufacturers Association, Bureau of Standards, National Machine Tool Builders Association, Ford Motor Company, The American Society of Mechanical Engineers, and Gage Manufacturers Association.

The committee prepared a draft standard based on the conversion ratio of 25.4:1 which was submitted to a general conference of more than 50 industrial and technical groups. The conference recommended unanimously the standard for acceptance, and after being submitted to additional national groups the standard was approved as an American Standard in 1933.

It was reaffirmed in 1947.

In addition to specifying the conversion factor of one inch = 25.4 millimeters, the standard contains three conversion tables based on this factor—Table 1, Inches to Millimeters; Table 2, Millimeters to Inch; and Table 3, Common Fractions of an Inch to Millimeters.

Z25.1-1940—American Standard Rules for Rounding Off Numerical Values.

The general conference held in 1932 to recommend the establishment of an American Standard Practice for Inch-Millimeter Conversion also resolved that it would be useful to establish an American Standard practice for rounding off numerical values.

The same committee that developed the inch-millimeter conversion factor was charged with this task. In 1938, a draft standard was circulated among professional societies in the fields of mathematics, physics, chemistry, engineering, education, insurance, and statistics for criticism. No objections were registered and only a few suggestions for changes in the draft were made. After minor revisions in the text, the draft was approved as an American Standard in 1940.

The main purpose of the standard is to insure a uniform procedure in rounding off decimals while retaining statistical accuracy. The standard provides specific rules for all cases of "rounding up" and "rounding down," and also includes a table for rounding off decimals from one to six places.

Copies of American Standards B48.1 (50 cents each) and Z25.1 (35 cents each) are available from the American Standards Association, Dept. PR52, 70 East 45th Street, New York 17, N. Y.

Columbia Breaks Ground for New Engineering Center

"Will our colleges and universities be ready to give the ablest of the young people who will come to them in the next few years the educational opportunity they should have?" This was the question posed by Grayson Kirk, president of Columbia University, at the annual Dean's Day program of the Columbia School of Engineering.

One of the events of the day, in part, answered this question in the affirmative. High light of the day's program was the ground-breaking ceremony for Columbia's large new Engineering Center.

The building, to cost $8.3 million, will rise on the University campus at 120th Street and Amsterdam Avenue. It will provide expanded facilities for the University's already-vast engineering program.

The Seeley Wintersmith Mudd Building, first unit of the new Center, will be a 13-story structure with classrooms, laboratories, and administrative offices for mining, metallurgical, and mineral engineering, as well as mechanical, civil, electrical, industrial, and chemical engineering departments. The building will be fully air conditioned. Architects are the New York firm of Voorhees, Walker, Smith, Smith and Haines.

Construction was made possible by many bequests to the Engineering Center, particularly one of about $6 million from the late Henry Krumb. Other major gifts included one from the Seeley Wintersmith Mudd Foundation of Los Angeles, and one from the Ambrose Monell Foundation of New York.

President Eisenhower in his congratulatory message to Felix E. Wormser, former Assistant Secretary of the Interior and first chairman of Columbia's Engineering Center Fund Campaign, says of the project, "Incidentally, it is a good thing that we never quite realize the enormity of some of the major tasks we undertake."

With the beginning of construction on the new Center, Columbia sets out to complete a major task—enormous though it may be—to continue to produce men and women whose professional skills and qualities of leadership are underpinned by wisdom and intellectual capacity born in an important university center.

Other featured events of the annual Dean's Day ceremonies included the presentation of two major awards. John R. Dunning, Mem. ASME, and dean of the Columbia School of Engineering, received the Michael Pupin Medal for "service to the nation." Presentation of the medal commemorates the one-hundredth anniversary of the birth of the noted inventor who was a professor at Columbia. The Egleston Medal was presented to Robert A. W. Carleton for "distinguished engineering achievement."

Groundbreaking—Dr. Grayson Kirk, *right*, president of Columbia University, watches while John R. Dunning, Mem. ASME, dean of the University's School of Engineering, turns earth to signify the start of construction of the University's new Engineering Center. The first building to rise in the new Center will be the Seeley Wintersmith Mudd Building, the thirteen-story structure depicted in the artist's drawing at the rear.

EDUCATION

Summer Courses

- Cornell University. Annual industrial engineering seminars to be held at Ithaca, N. Y., June 16–19. For additional information write: Andrew Schultz, Jr., Department of Industrial and Engineering Administration, Upson Hall, Cornell University, Ithaca, N. Y.
- Massachusetts Institute of Technology. A wide variety of summer courses for engineers are being offered at the school, notably: seven courses in the field of mechanical engineering, four in industrial management, and a course on scientific and engineering reports. Write to: Prof. J. M. Austin, Director of Summer Session, Room 7-7101, M. I. T., Cambridge 39, Mass.
- The University of Michigan. Registration for courses ranging from technical writing to advanced theory of logical design of digital computers would be completed by April 15 for June courses, and June 15 for July, August, and September courses. For information, write: R. E. Carroll, Engineering Summer Conferences, 126 West Engineering Building, Ann Arbor, Mich.
- University of North Carolina. The University's Extension Division will sponsor an introductory course on the use of digital computers from August 17–28. Application should be made before June 15 to: J. G. Steagall, University Extension Division, Box 1050, Chapel Hill, N. C.
- Pennsylvania State University. A plastics-engineering seminar will be held June 28–July 3. Emphasis will be placed upon new developments in high polymers and plastics engineering. Information available from: Extension Conference Center, The Pennsylvania State University, University Park, Pa.
- Polytechnic Institute of Brooklyn. Russian for Research, two intensive, six-week-long summer courses designed for scientists and engineers who must keep abreast of current Russian publications, will be offered. Information on the two offerings can be obtained from the Department of Modern Languages, Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn 1, N. Y.

Standardization

Dr. John Gaillard, Mem. ASME, consultant on industrial standardization, will hold his next five-day seminar on this subject in New York City, from June 22 through June 26, 1959. His seminars are intended to assist top management in establishing the administrative setup and procedure for most effective handling of standardization work in the individual company, and in training staff men in the functions of the standards engineer, including the art of writing specifications.

For details and registration, write to Dr. John Gaillard, 135 Old Palisade Road, Fort Lee, N.J.

Robert Cornish, ***left,*** **receives certificate from E. W. Allardt for C-A-M Section outstanding success in Member Gifts Campaign**

United Engineering Center

E. W. Allardt presents L. L. Bosch with certificate for successful campaign conducted by Cincinnati Section

Recently, Ernst W. Allardt as Vice-President ASME Region V, and head of the Member Gifts Campaign for that area, wrote to his "constituents." With his permission, we are reproducing here some excerpts from his message in the belief that his ideas apply not only to members in the Ohio Valley, but to ASME members everywhere.

"Many ASME members have made contributions to the United Engineering Center Building Fund, something which those of us on the Member Gifts Committee sincerely appreciate. A large part of the membership, however, has not yet responded. These are some of the reasons why we believe further consideration is in order.

"The new Engineering Center is not planned to be a monumental structure, but rather a functional modern building to adequately house the administrative staffs of the five Founder Societies and sixteen others. Our ASME staff will be in a position to give much improved service to our members and the hundreds of committees serving the Society. The now overcrowded Engineering Societies Library of 178,000 volumes is also to be housed in the new building that is to replace the outmoded, outgrown, 53-year old building originally donated by Andrew Carnegie.

"A few members who have not given have come up with an amazing number of excuses and resentments. One of the most common is: "I have never visited Headquarters, nor used the library—I may not do so in the future." These same members, perhaps, have never visited the National Capital, the House and Senate office buildings, nor the White House. Perhaps, they have not visited their State Capital and its office buildings. Possibly, the only time they visit their City Hall is to pay a parking fine. Nevertheless, all of these buildings are necessary. We forget also that we have paid for them and we continue every year to pay maintenance and addition costs. A new United Engineering Center is just as great a necessity to provide for the present and future growth of our Engineering Societies, and properly house our staffs.

"It is true, of course, that in 1958 business was generally poor—it was, perhaps, a comparatively poor time for soliciting building funds. Now business is on the upturn, it should not be so difficult to obtain funds and complete the campaign reasonably soon.

"I am urging all those who have not contributed to re-examine their attitudes, shed those that are negative, chauvinistic, or based on misunderstanding, and substitute positive ones indicative of appreciation, a proper professional attitude, and helpfulness. Then contribute according to the dictates of your conscience, realizing that even a small sum will be acceptable. It is pre-eminently important to GIVE, to support your profession, and to co-operate with fellow members."

THE SCORE BY SECTIONS

	PER CENT PLEDGED	
	of Quota	of Members
REGION I	49.8	20.3
Boston	45.9	20.0
Fairfield Co.	60.3	23.3
No. New England	0.5	0.4
Hartford	17.3	10.7
New Haven	32.8	8.5
New London	39.7	28.6
Providence	77.4	24.3
WATERBURY	**182.1**	44.0
Western Mass.	47.6	30.7
Worcester	86.3	37.4
REGION II	65.3	20.2
Mid-Jersey	47.5	17.9
Metropolitan	68.0	20.0
Mid-Hudson	67.6	36.6
REGION III	51.6	22.6
Anthra-Lehigh	73.6	29.4
Baltimore	55.4	29.7
Buffalo	12.7	6.1
Central Pa.	21.7	18.2
Southern Tier	88.5	46.0
Philadelphia	39.5	16.2
Rochester	78.5	36.1
HUDSON-MOHAWK	**116.7**	42.7
Susquehanna	0.0	0.0
Syracuse	34.0	12.2
Washington, D.C.	12.1	7.5
Delaware	71.2	29.2
OLEAN	**102.8**	56.9
REGION IV	34.4	15.4
ATLANTA	**119.3**	18.0
Birmingham	66.1	29.4
Pied-Carolina	34.4	25.1
E. Tennessee	18.0	10.9
Florida	0.4	0.2
Greenville	12.1	9.2
E. No. Carolina	13.2	10.0
Savannah	28.2	23.2
Virginia	6.2	6.1
Chattanooga	4.3	4.0
Miami	5.9	2.0
Central Savannah River Area	36.5	22.4
N. W. FLORIDA	**102.2**	58.5
REGION V	69.6	27.9
Akron	40.9	23.6
CINCINNATI	**152.3**	52.7
Cleveland	44.3	20.0
Columbus	54.1	30.4
DAYTON	**142.1**	26.7
Detroit	61.1	23.2
Erie	58.6	30.6
Ontario	27.9	10.5
Pittsburgh	60.9	28.6
Toledo	9.7	6.0
W. VIRGINIA	**101.4**	53.8
Youngstown	48.3	8.0
CANTON-ALLIANCE-MASSILLON	**144.2**	47.2
Westmoreland	39.7	30.5
REGION VI	58.9	29.7
Cen. Indiana	93.4	38.5
Chicago	57.1	28.7
Fort Wayne	96.5	45.6
Louisville	18.3	11.2
Milwaukee	68.4	32.7
Minnesota	63.0	33.0
Nebraska	65.3	46.6
Cen. Illinois	54.5	39.8
Rock River Val.	87.7	25.6
St. Joseph Val.	11.3	7.0
St. Louis	32.3	23.2
Iowa-Illinois	76.0	42.6
Central Iowa	69.8	22.1
REGION VII	30.5	17.2
Inland Empire	37.4	29.7
Los Angeles	19.3	9.3
San Diego	52.3	34.4
Hawaii	79.1	38.0
Oregon	12.6	14.7
San Francisco	33.8	19.3
Utah	29.2	15.1
West. Washington	51.4	25.8
Arizona	46.3	32.1
Columbia Basin	47.8	35.2
REGION VIII	21.6	12.0
Rocky Mt.	23.5	13.4
Kansas City	12.9	1.6
Mid-Continent	22.5	13.1
New Mexico	36.7	21.6
New Orleans	13.7	6.8
North Texas	14.7	10.5
Sabine	41.0	21.3
South Texas	27.2	15.4
Mexico	15.0	7.1
Central Kansas	25.3	20.4

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Notes on
Society Activities
and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

Meet Me In "Air-Conditioned" St. Louis for the ASME Semi-Annual Meeting, June 14–18, 1959

THE Semi-Annual Meeting of The American Society of Mechanical Engineers will be a week of concentrated activities running the full range of professional society endeavors plus a generous sprinkling of lighter-vein activities.

Administratively, there will be meetings of the ASME Council, Professional Divisions, Regional Delegates, Nominating Committee, and the official Business Meeting of the Society.

Technically, there will be a varied and comprehensive coverage of the field of mechanical engineering. Thirty-five sessions sponsored by 20 Professional Divisions at which some 81 papers will be presented. In addition, four panel sessions are planned. The program is outlined and will be amplified in the advance program to be distributed to the membership early in May.

Visually, there will be plant visits offering answers to widely varied interests: For those inclined to power plants the Meramec Station of the Union Electric system where boilers, turbines, and accessories in operation and under construction will be inspected, also the Combustion Engineering Company's fabrication plant where package-boiler construction will be seen; for those interested in maintenance of equipment, the shops of the St. Louis Public Service Company present some of the most modern facilities for repair, reconstruction, and general maintenance of buses and automotive equipment; for those inclined to heavy industry and metal processing the blast furnaces, open hearths, and rolling mills of Granite City Steel Company will be available; for the process-industry-minded visitors a trip to Anheuser-Busch Brewery will be a well-spent afternoon; of general and unusual interest will be a trip to the plant of the St. Louis Shipbuilding and Steel Company where barges and tow boats will be under construction, and we hope there will be a launching; and, finally, for visitors having other interests special access can be arranged for any of the wide variety of St. Louis industry such as oil refineries, foundries, electric manufacturing, aviation, chemical processing, and what have you!

Luncheons, Banquet, Social Events

Supplementing the technical sessions will be luncheons each day: President's Luncheon, Management Division, Power Division, and Technical Development groups. The banquet will be highlighted by a talk by General Leif J. Sverdrup and the presentation of the Spirit of St. Louis Medal and the Spirit of St. Louis Junior Award for recognition of achievement in the aviation field.

All work and no play are bad for engineers as well as for youngsters, so there will be social activities: An Early Bird Get-Acquainted Party, an evening at the Open-Air Opera presentation of "The King and I," a National League ball game between the St. Louis Cardinals and the Philadelphia Phils, a cocktail hour preceding and dance following the Banquet. To suit any palate, there is a choice of eating places, night clubs, river excursions, showboat melodrama, theaters, an unsurpassed zoo, and many other possibilities.

Women's Program

The wives of conferees are urged to come to St. Louis for the meeting. Many plans are being formulated by the Ladies' Program Committee. There will be a hospitality room available for assembling for organized activities, for visiting and becoming acquainted, and for obtaining information; a visit to Grant's Farm on the Busch family estate; a visit to the Missouri Botanical Gardens (Shaw's Garden); a specially arranged and guided tour and luncheon at the Art Museum; a charm and fashion show session; and, of course, participation in the other social activities.

"Water—Lifeblood of Industry" Topic to Be Featured in Two Sessions

TWO SPECIAL technical sessions and a luncheon meeting devoted to the theme, "Water—Lifeblood of Industry," will be a high light of the 1959 ASME Semi-Annual Meeting. This event, developed and sponsored by ASME's forward looking Technical Development Committee, is scheduled for Thursday, June 18, of the meeting.

At the first session, Dr. John G. Ferris of the U. S. Geological Survey, will give a broad picture of water and water conservation. Dr. Ferris will discuss surface water and the growing importance and problems of ground water flow systems. In another paper, Paul Weaver, formerly of the Gulf Oil Company, and now Distinguished Professor of Geology and Geophysics at Texas A&M will discuss the development and completion of water wells. He will cover not only wells for taking water out of the ground but also wells for putting water into the ground, and the movement of fluids into and out of permeable structures.

Following the morning session, Dr. Gary Higgins of the Chemistry Department, Lawrence Radiation Laboratory of the University of California at Livermore, Calif., will present the latest story on Operation Plowshare at the luncheon session. His presentation will include a short film.

The afternoon session will include two papers covering the use and re-use of water. Dr. Everett Partridge will cover the general philosophy on the use and re-use of water in industry, while Kenneth Watson of the General Electric Company will present some case studies from industry.

SEMI-ANNUAL BANQUET

B WEDNESDAY, JUNE 17 7:00 p.m.

Address by: *General Leif J. Sverdrup*, Sverdrup & Parcel, Inc.

Presentation of 1958 Spirit of St. Louis Medal to *George S. Schairer*, Boeing Airplane Co.

Presentation of 1958 Spirit of St. Louis Junior Award to *Melvin L. Baron*, Paul Weidlinger Consulting Engineer, Columbia Univ.

PRESIDENT'S LUNCHEON

L MONDAY, JUNE 15 12:15 p.m.

Welcome Remarks: The Hon. *Raymond R. Tucker*, Mem. ASME, Mayor of the City of St. Louis

Address by: *Glenn B. Warren*, ASME President

AIR POLLUTION CONTROLS SESSION

I THURSDAY, JUNE 18 2:30 p.m.

Stack-Emission Control During Power-Plant Load Cycling, by *J. F. McLaughlin, Jr.*, and *G. V. Williamson*, Union Elec. Co. (Paper No. 59—SA-28)

Fume Agglomeration and Filtration at High Temperatures, by *Leslie Silverman* and *C. E. Billings*, Harvard School of Public Health

Panel Discussion: Problems of Air-Pollution Control in a Bi-State City

J. H. Carter, Div. of Smoke Regulation
Elmer Wheeler, Monsanto Chemical Co.
G. V. Williamson, Union Elec. Co.

AVIATION SESSIONS

I WEDNESDAY, JUNE 17 9:30 a.m.

Jointly With Gas Turbine Power

The Shock-Wave Noise Problem of Supersonic Aircraft,[1] by *H. H. Hubbard* and *D. J. Maglieri*, NASA

Technical and Economic Factors of Supersonic Transport,[1] by *F. A. Payne*, North American Aviation, Inc.

Designing Tomorrow's Commercial Supersonic Transport Engine, by *G. C. Rapp*, Gen. Elec. Co. (Paper No. 59—SA-32)

II WEDNESDAY, JUNE 17 2:30 p.m.

Jointly With Gas Turbine Power

Staged Supersonic Transports: The Small Airplane Returns, by *Walter Daskin*, *Lewis Feldman*, and *Ernest Sanlorenso*, Gen. Applied Science Labs., Inc. (Paper No. 59—SA-31)

The Ramjet Transport: Savings, Sooner, and Safer,[1] by *J. F. Drake* and *R. T. DeVault*, Marquardt Aircraft Co.

Design of Rocket Engines for Aircraft,[1] by *J. M. Cumming*, Rocketdyne, Div. of North American Aviation, Inc.

Tactical and Operational Advantages Attainable by Superperformance Aircraft-Rocket Engines,[1] by *C. R. Bell*, Rocketdyne, Div. of North American Aviation, Inc.

III THURSDAY, JUNE 18 9:30 a.m.

Jointly With Gas Turbine Power

Some Conclusions on VTOL Flight Characteristics and Future Developments Based on XV-3 Convertiplane Tests,[1] by *C. E. Leibensberger*, Bell Helicopter Corp.

The Importance of Qualitative Factors in VTOL Transport Selection,[1] by *L. R. Novak*, McDonnell Aircraft Corp.

Product Analysis of Tilt Wing Propelloplane-Type VTOL Aircraft,[1] by *J. B. Nichols*, Hiller Aircraft Corp.

FUELS SESSION

I THURSDAY, JUNE 18 9:30 a.m.

Steam-Electric Power for Primary Aluminum Smelting,[1] by *V. Z. Caracristi* and *H. D. Mumper*, Combustion Engrg., Inc.

Application of Cyclone-Furnace Firing to Industrial Boilers,[1] by *W. H. Jackson*, The Babcock & Wilcox Co.

GAS TURBINE POWER SESSIONS

I WEDNESDAY, JUNE 17 9:30 a.m.

Jointly With Aviation

See Aviation I

II WEDNESDAY, JUNE 17 2:30 p.m.

Jointly With Aviation

See Aviation II

III THURSDAY, JUNE 18 9:30 a.m.

Jointly With Aviation

See Aviation III

HEAT TRANSFER SESSIONS

I TUESDAY, JUNE 16 2:30 p.m.

Heating and Cooling Air and Carbon Dioxide in the Thermal Entrance Region of a Circular Duct With Large Gas to Wall Temperature Differences, by *Helmut Wolf*, Rocketdyne (Paper No. 59—SA-15)

Reactor Heat Transfer—A Preliminary Design Procedure, by *W. A. Sutherland*, Argonne Nat. Lab. (Paper No. 59—SA-16)

Turbulent Flow in a Circular Tube With Arbitrary Internal Heat Sources and Wall Heat Transfer, by *Robert Siegel* and *E. M. Sparrow*, NASA, Lewis Research Center (Paper No. 59—SA-19)

II WEDNESDAY, JUNE 17 9:30 a.m.

The Use of Thin Films for Increasing Evaporation and Condensation Rates in Process Equipment, by *E. L. Lustenader*, *R. Richter*, and *F. J. Neugebauer*, Gen. Elec. Co. (Paper No. 59—SA-30)

Laminar Condensation Heat Transfer on a Horizontal Cylinder, by *E. M. Sparrow* and *J. L. Gregg*, NASA, Lewis Research Center (Paper No. 59—SA-13)

III WEDNESDAY, JUNE 17 2:30 p.m.

Optimization of a Conventional Fuel-Fired Thermoelectric Generator, by *B. W. Swanson* and *E. V. Somers*, Westinghouse Research Labs. (Paper No. 59—SA-14)

Numerical Solutions to an Inverse Problem of Heat Conduction for Simple Shapes, by *George Stolz, Jr.*, Columbia Univ. (Paper No. 59—SA-20)

HUMAN FACTORS SESSION

I WEDNESDAY, JUNE 17 9:30 a.m.

Jointly With The Society of Engineering Psychologists and Human Factors Society

Panel Session

Human Factors in Engineering Education—The Industrial View, by *A. K. Simons*, Bostrom Research Labs.

Human Factors in Engineering Education—The Psychologists View, by *P. M. Fitts*, Univ. of Michigan

Human Factors in Engineering Education—The Engineering View, by *H. O. Davidson*, Georgia Inst. of Tech.

JUNIOR SESSION

I MONDAY, JUNE 15 2:30 p.m.

Jointly With Management

The Young Engineer and His Future

The Young Engineer and the Manager Look at Each Other,[1] by *G. V. Williamson*, Union Elec. Co.

The Development of Engineering Personnel for Managerial Assignments,[1] by *K. H. Rivett*, Albert Ramond & Associates

Creative Thinking—An Engineering Method, by *D. L. Purdy*, Gen. Elec. Co. (Paper No. 59—SA-26)

LUBRICATION SESSION

I TUESDAY, JUNE 16 2:30 p.m.

Jointly With Machine Design

1958 Abstract—Fluid-Film Bearings,[1] by *Richard Elwell*, Gen. Elec. Co.

1958 Abstract—Rolling Elements,[1] by *Paul Lewis*, Gen. Elec. Co.

1958 Abstract—Lubricants,[1] by *J. Cunningham*, Gulf Research & Development Co.; *A. C. Schwarts*, Gen. Elec. Co.; and *M. C. Shaw*, M.I.T.

1958 Abstract—Friction and Wear,[1] by *W. Shugarts*, The Franklin Inst.

Flow Parameters in Hydrostatic Lubrication for Several Bearing Shapes,[1,2] by *S. Raynor*, Northwestern Univ.

MACHINE DESIGN SESSIONS

I MONDAY, JUNE 15 9:30 a.m.

Static and Dynamic Behavior of Flexible Torsional Couplings With Nonlinear Characteristics, by *Ali Seireg*, The Falk Corp. (Paper No. 59—SA-8)

Pressure-Actuated Cylindrical Diaphragm Seals, by *C. Y. Neou*, Univ. of Bridgeport (Paper No. 59—SA-1)

Registration Schedule

Sunday, June 14,	2:00 p.m. to 5:00 p.m.
Monday, June 15,	8:00 a.m. to 3:00 p.m.
Tuesday, June 16,	8:00 a.m. to 3:00 p.m.
Wednesday, June 17,	8:00 a.m. to 3:00 p.m.
Thursday, June 18,	8:00 a.m. to 12:00 noon

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[1] Paper not available—see box on page 116.

[1] Paper not available—see box on page 116.
[2] Not presented orally.

Orders for ASME Technical Papers

Only copies of *numbered* ASME papers will be available. Please order only by paper *number;* otherwise the order will be returned. Order your copies of *numbered* papers by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Production problems may delay the availability of some numbered papers. However, orders will be held for such papers only until May 29, 1959.

Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten, are $3 to members; $6 to nonmembers.

Copies of unnumbered papers, listed in this program, *are not available* in advance of the meeting because the review of these manuscripts had not been completed when the program went to press.

The August, 1959, issue of Mechanical Engineering will contain a complete listing of all available papers.

The Automobile Engine as a Dynamic Vibration Absorber, by *J. A. Carlson*, Teletype Corp. (Paper No. 59—SA-10)

II MONDAY, JUNE 15 2:30 p.m.

Quantitative Investigation of the Factors Which Influence the Fatigue Life of V-Belts, by *S. M. Marco* and *W. L. Starkey*, Ohio State Univ.; and *K. G. Hornung*, Dayton Rubber Co. (Paper No. 59—SA-18)

A Mechanical Time-Delay Device Sensitive to Centrifugal Fields, by *J. R. Baumgarten*, Whirlpool Corp.; *R. Cohen* and *A. S. Hall, Jr.*, Purdue Univ. (Paper No. 59—SA-9)

Experimental Study of Gas Systems for Automatic Mechanisms,[1] by *Frederick Bock* and *M. G. Kinnavy*, Armour Research Foundation of Illinois Inst. of Tech.

III TUESDAY, JUNE 16 9:30 a.m.

Dynamic Analysis of a Cylindrical Cam, by *R. J. Fanella*, Armour Research Foundation of Illinois Inst. of Tech. (Paper No. 59—SA-3)

Nomographic Synthesis of Computer Linkages, by *D. P. Adams*, M.I.T. (Paper No. 59—SA-11)

Effect of Presetting Helical Compression Springs, by *T. J. Atterbury*, Battelle Memorial Inst.; and *W. B. Diboll, Jr.*, Washington Univ. (Paper No. 59—SA-12)

IV TUESDAY, JUNE 16 2:30 p.m.

Jointly With Lubrication

See Lubrication

MAINTENANCE SESSIONS

I TUESDAY, JUNE 16 9:30 a.m.

Jointly With Power

Criteria of Equipment Reliability Evaluation, by *I. J. Karassik*, Worthington Corp. (Paper No. 59—SA-2)

Precompensating Turbine-Generator Alignment for Temperature Effects on the Foundation,[1] by *J. L. Berry*, Union Elec. Co.

II TUESDAY, JUNE 16 2:30 p.m.

Jointly With Safety

See Safety

MANAGEMENT SESSIONS

I MONDAY, JUNE 15 2:30 p.m.

Jointly With Junior

See Junior

II TUESDAY, JUNE 16 9:30 a.m.

Research and Engineering Management

Research and Engineering Management and Controls,[1] by *S. R. Irish*, Olin-Mathieson Chemical Corp.

Computers in Research and Engineering,[1] by *Leon Cooper*, Monsanto Chemical Co.

Expressing Business Opportunities in Terms of Product Requirements,[1] by *D. E. Chambers*, Gen. Elec. Co.

TUESDAY, JUNE 16 12:15 p.m.

L Management Luncheon

Speaker: *Howard K. Nason*, Monsanto Chemical Co.
Subject: **Management's Changing Responsibilities**

III TUESDAY, JUNE 16 2:30 p.m.

The Business of Engineering

Engineering for Profit,[1] by *H. J. Richmond*, A. T. Kearney & Co., Management Consultants

Integrated Cost Reduction,[1] by *C. W. Nedderman*, Edward Valves, Inc., Div. of Rockwell Mfg. Co.

The Budget Nobody Talks About,[1] by *A. R. Adler*, Gen. Elec. Co.

MATERIALS HANDLING SESSIONS

I MONDAY, JUNE 15 9:30 a.m.

Transportation Considerations in the Selection of a Bulk-Handling System, by *N. H. Brown, Jr.*, U. S. Rubber Co. (Paper No. 59—SA-7)

Dust-Tight Screw Conveyer Design, by *A. L. Lyons*, Monsanto Chemical Co. (Paper No. 59—SA-5)

II MONDAY, JUNE 15 2:30 p.m.

Flow Behavior of Bulk Grain,[1] by *H. J. Barre*, consulting agricultural engineer, Mansfield, Ohio

Containerization of Bulk-Material Handling, by *F. J. White, Jr.*, Tote System, Inc. (Paper No. 59—SA-6)

NUCLEAR ENGINEERING SESSIONS

I WEDNESDAY, JUNE 17 2:30 p.m.

Panel Discussion: Power Reactor Safeguards

C. R. Braun, Allis-Chalmers Mfg. Co.
W. F. Banks, ACF Industries, Inc.
J. H. MacMillan, The Babcock & Wilcox Co.
M. E. Maider, Gen. Elec. Co.
W. E. Shoupp, Westinghouse Elec. Corp.
C. A. Trilling, Atomics International, Div. of North American Aviation, Inc.
W. J. McCarthy, Jr., Atomic Power Development Assoc., Inc.

II THURSDAY, JUNE 18 9:30 a.m.

Panel Discussion: Power Reactor Fuels

W. W. Galbreath, The Babcock & Wilcox Co.
Wayne Jens, Atomic Power Development Assoc., Inc.
William Leaders, Mallinckrodt Nuclear Corp.
W. E. Parkins, Atomics International, Div. of North American Aviation, Inc.
M. J. Sanderson, Gen. Elec. Co.
Zalman Shapiro, Nuclear Materials & Equipment Corp.

OIL AND GAS POWER SESSION

I TUESDAY, JUNE 16 9:30 a.m.

Injection Equipment for Residual Fuels,[1] by *P. G. Burman*, American Bosch Arma Corp.

Research on Charge Stratification for Four-Stroke Cycle Spark Ignition Engines, by *L. D. Conta* and *Pandeli Durbetaki*, Univ. of Rochester (Paper No. 59—SA-25).

POWER SESSIONS

I TUESDAY, JUNE 16 9:30 a.m.

Jointly With Maintenance

See Maintenance I

II WEDNESDAY, JUNE 17 9:30 a.m.

Sea-Water Distillation With By-Product Power at Aruba, by *G. E. Sonderman*, Singmaster & Breyer (Paper No. 59—SA-24)

Influence Coefficients for Open-Crown Hemispheres, by *G. D. Galletly*, Shell Development Co. (Paper No. 59—SA-4)

Cooling-Tower Fan Performance, by *N. W. Kelly*, J. F. Pritchard & Co. of California; and *G. W. Forman*, Univ. of Kansas (Paper No. 59—SA-17)

L WEDNESDAY, JUNE 17 12:15 p.m.

ASME National Nominations

The 1959 Nominating Committee is to meet for two days, June 15–16, 1959, at the Chase-Park Plaza Hotel in St. Louis, Missouri, where the Semi-Annual Meeting will be held. Hearings will be held so that members may speak in behalf of their candidates for the office of President, Regional Vice-Presidents, and Directors any time between the hours of 10:00 a.m. to 12:00 noon; and from 2:00 p.m. to 5:00 p.m. (or, if necessary, from 8:00 p.m. to 9:30 p.m.) on Monday, June 15, and on Tuesday, June 16, from 9:00 a.m. to 12:00 noon and, if necessary, from 2:00 p.m. to 4:00 p.m. Following the close of business of the 1959 Nominating Committee there will be held an Organization Meeting of the 1960 Committee presided over by A. H. Jensen, chairman of the 1959 Committee. This meeting will take place on Tuesday afternoon or evening, June 16, following the Business Meeting of the 1959 Committee or, if necessary to extend the Business Meeting through Tuesday evening, the Organization Meeting will be held at 9:30 a.m., Wednesday, June 17.

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[1] Paper not available—see box on this page.

Notice of Regular Business Meeting of The American Society of Mechanical Engineers

NOTICE is hereby given that a regular Business Meeting of the members of The American Society of Mechanical Engineers will be held on June 15, 1959, at 4:45 p.m., at the Chase-Park Plaza Hotel, St. Louis, Mo., for the purpose of considering and transacting the following business:

1 Amending the first independent clause of Article THIRD of the Certificate of Incorporation of the Society as modified by the Order of Consolidation of the Supreme Court of New York County on October 17, 1907, to read: "The number of directors to manage the Society shall be not less than twenty-two nor more than thirty-three."

NOTE: The original Charter in 1881 provided that "the number of trustees, directors or managers to manage the Society shall be eighteen," and the 1907 Order of Consolidation provided that the number of directors "shall be twenty-two."

2 Announcement of Location of 1960 Semi-Annual Meeting
3 Election of Nominating Committee for 1960
4 Constitutional Amendments
5 Report on Unity of Engineering Profession
6 Report on United Engineering Center
7 Such Other Business as May Properly Come Before the Meeting

OBSchier II

May, 1959

O. B. Schier, II,
Secretary

Power Luncheon

Speaker: *G. V. Williamson*, Union Electric Co.
Subject: **Engineering Research in the Power Field**

III WEDNESDAY, JUNE 17 2:30 p.m.

Meramec No. 3 Steam Electric-Generating Unit, by *C. H. Rulfs* and *J. K. Bryan*, Union Elec. Co. (Paper No. 59—SA-27)

Some Design Features of the Meramec Twin Furnace Reheat Steam Generator,[1] by *M. F. Dallen* and *H. H. Hemenway*, Foster Wheeler Corp.

Steam-Flow Distribution at the Exhaust of Large Steam Turbines,[1] by *R. E. Brandon* and *J. E. Fowler*, Gen. Elec. Co.

IV THURSDAY, JUNE 18 9:30 a.m.

Direct Conversion of Heat Into Electric Energy

The Fuel Cell. Status and Background, by *H. A. Liebhafsky* and *D. L. Douglas*, Gen. Elec. Co. (Paper No. 59—SA-22)

Thermoelectric Adjuncts in Thermodynamic Systems,[1] by *N. E. Lindenblad*, RCA Labs.

Thermionic Converter, by *V. C. Wilson*, Gen. Elec. Research Lab. (Paper No. 59—SA-23)

PROCESS INDUSTRIES

SESSIONS

I TUESDAY, JUNE 16 9:30 a.m.

Secondary Benefits of Pneumatic Conveying, by *John Fischer*, Sprout, Waldron & Co. (Paper No. 59—SA-29)

Loading and Unloading of Dry Material in Railroad Cars, by *H. A. Stoess, Jr.*, Fuller Co. (Paper No. 59—SA-34)

Development and Uses of a New Line of Vibratory Feeders and Unit Vibrators, by *A. F. Israelson*, Eriez Mfg. Co. (Paper No. 59—SA-33)

II TUESDAY, JUNE 16 2:30 p.m.

Designing to Prevent Corrosion in the Process Industry,[1] by *F. L. Whitney, Jr.*, Monsanto Chemical Co.

Extended Surface Process Heat Exchangers,[1] by *W. H. Stahlheber*, The Trane Co.

Metallizing in the Process Industries,[1] by *W. B. Meyer*, St. Louis Metallizing Co.

PROFESSIONAL PRACTICE COMMITTEE

SESSION

I MONDAY, JUNE 15 9:30 a.m.

Jointly With Missouri Association of Consulting Engineers

Registration as a Requirement for Professional Practice,[1] by *W. E. Bryan*, Missouri Board of Registration for Architects & Professional Engineers

Preparation of and Experience With Minimum Fees and Salary Schedules,[1] by *Joe Williamson, Jr.*, Williamson & Assoc., Consulting Engineers

Progress Toward Unity,[1] by *H. W. Honefenger*, Elliott Co.

Professional Ethics,[1] by *W. M. Cooper*, Monsanto Chemical Co.

RUBBER AND PLASTICS

SESSIONS

I MONDAY, JUNE 15 9:30 a.m.

Jointly With Textile Engineering

Field Testing of Tires Made With Tyrex Viscose Tire Cord,[1] by *F. B. Breazeale*, American Enka Corp. (Color, sound movie on recent road tests made with Tyrex cord will be shown.)

Tires and Tire Cords,[1] by *G. M. Sprowls*, Tyrex Inc.

Panel Discussion

II MONDAY, JUNE 15 2:30 p.m.

Jointly With Textile Engineering

Tire Testing,[1] by *J. W. Hannell*, E. I. du Pont de Nemours & Co., Inc.

Preparation and Processing of Nylon Tire Cord,[1] by *J. W. Bolmeyer*, E. I. du Pont de Nemours & Co., Inc.

Engineering Reduced Ply-Tires,[1] by *D. H. Heckert*, E. I. du Pont de Nemours & Co., Inc.

Recent Developments in Tire Cord Fabrics Other Than Rayon and Nylon,[1] by *C. A. Litzler*, C. A. Litzler Co., Inc.

SAFETY

SESSION

I TUESDAY, JUNE 16 2:30 p.m.

Jointly With Maintenance

Chemical Process Safety, by *G. L. Gorbell*, Monsanto Chemical Co. (Paper No. 59—SA-21)

Field Erection Safety,[1] by *V. D. AuBuchon*, Nooter Corp.

Why the Engineer is Interested in Accident Prevention,[1] by *B. S. Cornwell*, Insurers Service Corp.

STUDENT MEMBER COMPETITION

1959 OLD GUARD PRIZE

I WEDNESDAY, JUNE 17 9:30 a.m.

The names of six winners from Regional Student Conferences will appear in the final program after selection has been determined at conclusion of the last student conference on May 9.

II WEDNESDAY, JUNE 17 2:30 p.m.

The names of six additional winners from Regional Student Conferences will appear in the final program after selection has been determined at conclusion of the last student conference, May 9.

TECHNICAL DEVELOPMENT COMMITTEE

SESSIONS

I THURSDAY, JUNE 18 9:30 a.m.

Water—Lifeblood of Industry—Part 1

Water Resources in Industry's Future,[1] by *J. G. Ferris*, U. S. Geological Survey, U. S. Dept. of the Interior

Development and Completion of Water Wells,[1] by *Paul Weaver*, Distinguished Professor of Geology and Geophysics, Texas A&M

L THURSDAY, JUNE 18 12:15 p.m.

Technical Development Committee Luncheon

Speaker: *Gary Higgins*, Univ. of California
Subject: **Operation Plowshare**

II THURSDAY, JUNE 18 2:30 p.m.

Water—Lifeblood of Industry—Part 2

Industrial Water: Use, Re-Use, Misuse?[1] by *E. P. Partridge*, Hall Labs.

Use and Re-Use of Water by Industry,[1] by *K. S. Watson*, Gen. Elec. Co.

TEXTILE ENGINEERING

SESSIONS

I MONDAY, JUNE 15 9:30 a.m.

Jointly With Rubber and Plastics

See Rubber and Plastics I

II MONDAY, JUNE 15 2:30 p.m.

Jointly With Rubber and Plastics

See Rubber and Plastics II

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[1] Paper not available—see box on page 116.

[1] Paper not available—see box on page 116.

F. L. Schwartz, *left,* GTP Award Comm. Chairman, presents a certificate of appreciation to A. L. London, Mem. ASME

ASME Conference Reveals GAS TURBINE POWER Moves to Dominance

By the trend of development, Cincinnati, Queen City of the Ohio, has much to interest engineers. For example: G-E's nuclear and gas-turbine propulsion laboratories; a hotel that starts on the sixth floor atop a department store and office building; a network of modern expressways; and a suspension bridge across the Ohio (built in 1870, the same year as the Brooklyn Bridge), to list only a few of the remarkable steps that mark the growth of this metropolis.

By design, the 1959 ASME Gas Turbine Power Conference and Exhibit, held there March 8–11, at the Netherland-Hilton Hotel, also had much to interest engineers. Although less than six months have elapsed since the 1958 Gas Turbine Progress Report was published, the conference papers reported new information on aviation, marine, petrochemical, electric power, and automotive applications as well as on the hardware and theoretical problems of gas-turbine design.

Luncheons

Speakers at the two luncheons summarized the relation of the gas turbine to air and marine transportation. David Cochran, Mem. ASME, general manager of General Electric's flight propulsion laboratory at Evendale, Ohio, spoke on the aviation applications at the Welcoming Luncheon.

Not only is the gas turbine assuming dominance as the motive power for long-distance flights, he said, but a combination of gas-turbine components appears to be the answer to the city-center-to-city-center transportation need which the helicopter has not met. A journey from Times Square to the White House, for example, takes $4\frac{1}{2}$ hr and costs $52 when the helicopter furnishes the air portion of the travel. Gas-turbine-powered vertical-take-off-and-landing aircraft could do it in 2 hr for $20 with a little more work on power plant and other components.

More attention has to be paid to costs on long-range aircraft, as well, Mr. Cochran said. Stiffer competition can be expected from the internal-combustion engine now that commercial transportation is involved and costs have to be considered. These can no longer be neglected as they were when military necessity was the impetus for development.

Ernst W. Allardt, Vice-President, ASME Region V, delivered the welcoming remarks in the absence, because of illness, of ASME President Glenn B. Warren. He also presented a certificate to L. L. Bosch, Mem. ASME, on behalf of the Council, commending the Cincinnati Section on the outstanding success of the Member Gifts Campaign for the new United Engineering Center. An all-personal-contact campaign has yielded 152 per cent of quota. Mr. Bosch was not only chairman of the Member Gifts Campaign and past-chairman of the Section, but was also one of two Engineers of the Year selected by the Cincinnati Council of Technical and Scientific Societies, composed of 21 technical and scientific-society representatives.

Donald C. Berkey, Mem. ASME, general manager of the Jet Engine Department, General Electric Company, Cincinnati, was toastmaster at the luncheon.

Rear-Admiral W. A. Dolan, assistant chief, U. S. Navy Bureau of Ships, and president of the Society of Naval Architects and Marine Engineers, spoke of the gas turbine's relation to other power sources as it relates to marine transportation and military logistics at the Division Luncheon. "Essential during peace, it becomes mandatory during war" to maintain the interchange of raw materials on which the U. S. economy depends, he stated. Although the richest nation, we are also the most "have-not," requiring importation of 66 of the 77 strategic materials. He pointed out that more than half of the mineral production of the world is channeled to our productive machine. In a single year freight in excess of 100 million lb is moved by air, and one billion tons by water, to bridge the oceans around us. Safe passage by water is imperative if we are to carry the war to the enemy and protect "fortress America" which has been uninvaded since 1812.

Since nuclear power adds 25 to 30 per cent to the cost of ships, the U. S. must rely on current power plants for most ships. The gas turbine, on which the U. S. Navy has spent $40 million for research and development and $14 million for construction, is already competitive for some applications and closing the gap on others.

Admiral Dolan stated that the Russian Navy is now the second largest and the fastest growing. It includes over 450 submarines with three new ones added every two weeks. The most we have built in one year is 72. The Russian Navy includes no aircraft carriers, he said.

F. L. Schwartz, Mem. ASME, and chairman of the Gas Turbine Power Division Award Committee, presented a certificate of appreciation to A. L. London, Mem. ASME, for his work in furthering the interests of the Division.

Technical Sessions

Development problems, operating ex-

Left to right, Rear Admiral W. A. Dolan, speaker at the Division Luncheon; B. O. Buckland, Mem. ASME, and R. Tom Sawyer, Fellow ASME, discussion leaders

Left to right, Authors: B. E. Sells, GE; J. O. Stephens, Westinghouse; R. Friedrich, Siemens-Schuchertwerke; P. T. Vickers, General Motors; F. Baumgartner, Boeing

Session Chairman Ivan Monk, and Vice-Chairman L. C. Hoffmann

in Air, on Land, and in Sea

perience, and performance characteristics in a wide range of applications were described in the papers presented at the technical sessions of the conference.

Aviation Applications. Design studies for a 250-hp gas-turbine engine primarily for use in helicopters, for an aft-turbofan for transports, and for nuclear aircraft gas-turbine engines were presented, and a record build-up in overhaul life was described.

Feasibility studies have shown that it is now possible to design, develop, and build a small free-shaft gas-turbine aircraft engine that could provide future Army aircraft with greatly increased performance capability. A 235 to 250-hp engine of this type would have a 400-lb payload advantage over the reciprocating engine. Quantity production might be achieved within five years of the start of a development program estimated to cost from $16 to $20 million.

A significant improvement in altitude-cruise fuel economy and a major increase in power rating are possible with a new type of aft-turbofan aircraft power plant. Although the turbofan idea is a quarter-century old, a successful design dates only from 1950 and there are currently two American and four British models. In reality the turbofan is a sort of ducted propellor which adds its thrust to that of the jet. It has a special advantage in the Mach 0.7 to 1.2 range where neither the turboprop nor unassisted turbojet is at maximum efficiency. Unique "bluckets" which permit the fan blading to ride pickaback on the rotor buckets are used in the design which is a modification of the CJ805-3 commercial turbojet. Units will power American Airlines fleet of Convair CV 600 medium-range commercial transports.

Bristol Proteus is setting a new pattern of engine service and has achieved an all-time record on the build-up of overhaul life with the Bristol Proteus 705 turboprop. In two years, the engine has achieved a 2000-hr life between overhauls, permitting roughly two changes a year on a 10-hr-per-day basis, and considerable further extension is possible.

Alternative arrangements of the components in a nuclear-aircraft gas-turbine system were described in a paper which was largely a review because of security regulations.

A study of the relative thermal performance of carbon dioxide and helium in nuclear-power cycles showed that helium requires considerably less heat-transfer area than carbon dioxide in equivalent direct gas-turbine cycles. However, the basis of comparison appears to determine which is better for use in gas-cooled-reactor steam-turbine systems.

Petrochemical Applications. Reliability has been of paramount importance and improved thermodynamic-cycle performance has been significant in the acceptance which the petrochemical industry has given the industrial gas turbine. A gas-turbine gasifier which produces 1000 cu ft of process air at 1200 F and 12 psig has a 7800 Btu advantage over the 29,740 Btu required for a steam-turbine-driven compressor. The largest Westinghouse application is Creole Petroleum's gas-conservation plant in Venezuela where 19 8000-hp units are in service. The 1,000,000-hr-fired pioneering experience of El Paso Natural Gas Company with 32 General Electric gas turbines on the company's pipeline have demonstrated high availability, adequate flexibility, and low installation and operating costs.

Electric Power Applications. Although the gas turbine can not compete with the steam turbine except for peaking application, it offers practically the only reasonable solution to the peak-load problem, particularly where this is large. Brown Boveri is installing a 40,000-kw unit at Mayaguez, Puerto Rico, to supplement a 300,000 kw system where the yearly increase in power demand has been 23 per cent. Four 30,000-kw units are being installed in Vancouver, B. C., and another large peaking plant is under construction by Electricidad de Caracas in Venezuela.

Automotive Applications. Details of the rotary regenerators used on General Motors Whirlfire GT-305, which has brought fuel consumption down to an area where it is practical for automotive applications, were disclosed for the first time at the conference. A drum-type regenerator is used with a matrix composed of layers of heat-transfer surface (originally wire screen) and shim stock stacked up around the circumference. This pack of shims and heat-transfer surface is mechanically retained between two geared rims which are used both to drive the entire assembly and to position it in the engine structure. Further details will be given in a forthcoming issue of MECHANICAL ENGINEERING.

Marine Applications. Four-size ranges of gas turbines were dealt with in the papers on marine application. About 700 Boeing 502-series engines have been produced for the 150 to 300-hp range, of which about 360 have been for marine use. These are principally for plane-personnel boats, landing craft, minesweepers, and fog producers. Westinghouse has combined a fully developed aircraft turbojet engine with a lightweight free-wheeling power turbine to produce a compact 8000-hp propulsion

DETROIT MICHIGAN FORMSPRAG
OVER-RUNNING Clutches

Lycoming GAS TURBINE ENGINES
T53
Lycoming
T53-L-1

At the Gas Turbine EXHIBITS

unit for Naval marine service. The Maritime Administration recently completed two years of operation with a 6600-hp open-cycle gas-turbine-propulsion plant in the converted Liberty ship *John Sergeant*. More than 100,000 sea miles have been completed at an average of almost 16 knots compared with $10\frac{1}{2}$ knots for the original Liberty ship. Normal-power fuel rate averages 0.522 lb per ship, which is about 10 per cent lower than for a modern steam-turbine marine plant. Maintenance is superior to diesel and less crew is required for attending the plant than with conventional installations.

Liquid Cooling. Solar Aircraft is developing a three-stage liquid-cooled gas turbine under U. S. Navy Bureau of Ships sponsorship, designed to operate at 1750-F inlet with nonstrategic low-alloy components. This has been in progress over three years. Plug-in rotor blading secured with pin inserts has overcome the difficulties experienced with conventional fastening. The rotor blades are cooled with water in a closed forced-convection system, and the stators are cooled with air. Successful operation at more than design temperature, adequate corrosion protection, and general feasibility have been demonstrated.

Other papers dealt with the problems of heat transfer, the effect of ambient and fuel pressure on spray-drop size, transient response of components, the application of electrical analog theory in preliminary design, and other design problems.

Exhibits

Those attending the conference had an opportunity to view hardware as well as to listen to papers. Boeing, Brown Boveri, Clark Brothers, Garrett, General Electric, Lycoming, Solar Aircraft, and Westinghouse displayed gas turbines or models of them. Gears, clutches, high-speed couplings, thrust reversers, shaft seals, silencing equipment, fuel systems, combustion and electrical equipment, nozzles, nozzle rings, vanes, and governors were among the components exhibited by Formsprag, Koppers, Lear, Marman, McGregor, Nugent, and Woodward Governor. Air-cast, inert-gas, and vacuum castings, new alloys, and fabrication methods were displayed and explained by Austenal, Cleveland Graphite Bronze, Fabricast Division of GMC, and Misco Precision Casting. *Diesel Progress* and Temple Press Limited had publication displays.

Availability List—Gas Turbine Power Conference

The papers in this list are available in separate copy form until Jan. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members, $6 to nonmembers.

59—GTP-1 Development of a Three-Stage Liquid-Cooled Gas Turbine, by Sumner Alpert, R. E. Grey, and W. O. Flaschar

59—GTP-2 The Basic Heat-Transfer and Flow-Friction Characteristics of Six Compact High-Performance Heat-Transfer Surfaces, by W. M. Kays

59—GTP-3 Effect of Ambient and Fuel Pressure on Spray-Drop Size, by S. M. De Corso

59—GTP-4 Presentation of a Blade-Design Method for Axial-Flow Turbines, Including Design and Test Results of a Typical Axial-Flow Stage, by F. Baumgartner and R. Amsler

59—GTP-5 The Transient Response of Gas-Turbine-Plant Heat Exchangers—Regenerators, Intercoolers, Precoolers, and Ducting, by A. L. London, F. R. Biancardi, and J. W. Mitchell

59—GTP-6 Torsion of a Prismatical Bar Whose Section Is a Crescent, by F. Sisto

59—GTP-7 Summary of Design Studies of a 250-HP Gas-Turbine Engine, by S. H. Spooner

59—GTP-8 Description and Service Experience of Various Boeing Gas-Turbine Marine Applications, by V. A. Yeager

59—GTP-9 Performance Analysis of Plug Nozzles for Turbojet and Rocket Exhausts, by W. H. Krase

59—GTP-10 Development of the Bristol Proteus Turboprop to 2000-Hr Life Between Overhauls, by P. F. Green

59—GTP-11 40,000-Kw Gas-Turbine Power Plant—Mayaguez, Puerto Rico, by Z. S. Stys

59—GTP-12 Rotary Regenerators for the Whirlfire Vehicular Turbines, by P. T. Vickers

59—GTP-13 Design Considerations for Nuclear-Aircraft Gas-Turbine Engines, by D. R. Riley

59—GTP-14 Relative Thermal Performance of Carbon Dioxide and Helium in Nuclear-Power Cycles, by F. E. Tippets

59—GTP-15 Application of Electrical Analog Theory in the Preliminary Design of Air-Cooled Turbines, by R. Lang and E. N. Petrick

59—GTP-16 Operating Experience With Gas-Turbine Ships of the Maritime Administration, by C. C. Tangerini and D. H. Specht

59—GTP-17 Operating Experience in the Petrochemical Industry, by J. O. Stephens

59—GTP-18 A Lightweight 8000-HP Gas Turbine for Marine Propulsion, by Vincent Proscino

59—GTP-19 The Past, Present, and Future of Pipeline Gas Turbine, by A. H. Carameros, B. J. Mathews, and W. B. Moyer

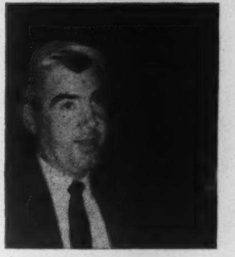
59—GTP-20 A Transport Aft-Turbofan. by B. E. Sells and W. R. Dodge

ASME Aviation Conference Looks at "This Shrinking World"

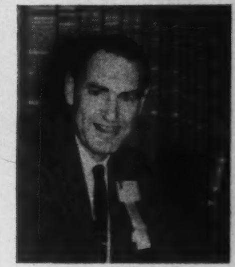
K. Ehricke, *left*, Convair-Astronautics, in CBS TV interview simplifies directions to Mars

W. L. Littlewood, American Airlines brings jet learning up to date

At banquet Admiral John Clark, ARPA, warns against space panic



Al Blackburn, North American Aviation, leads test pilots panel on their views on space ventures



George E. Hallen, ASME, Los Angeles Section Chairman, banquet's toastmaster

THE Aviation Division of The American Society of Mechanical Engineers held its 1959 Annual Conference in Los Angeles, Calif., March 9–12. The Conference, sponsored by the Division in co-operation with the ASME's Los Angeles Section and three California sections of the American Rocket Society, took place in the Statler Hilton Hotel. The theme was "This Shrinking World." Attendance was more than 900.

There were four main topics discussed at the technical sessions: Jet transports, satellite operation, propulsion, and missile and satellite logistics. Keyed to the Conference's thinking was the banquet speech of Rear Admiral John E. Clark, USN, who spoke on "Space Technology and Organization." The countdown has begun for putting man into space.

Earlier, at a luncheon, William Littlewood, a vice-president of American Airlines, had broached the earthy subject of noise suppression for jet airliners. The noise can be suppressed. The question is how much power we can afford to sacrifice to obtain lower noise levels.

At another luncheon there was a panel discussion by a group of test pilots, at which A. W. Blackburn of North American spoke on the overemphasis in automatic control. He urged that we recognize the need for the skill and perception of the human pilot, both in military operations and in space travel.

Vehicles for Space

The majority of the 64 technical papers presented and discussed during the three days of technical sessions came from scientists and engineers who form the spearhead of the drive to outer space, the men who will build America's space ships. The conference amounted to a complete review of the latest available information not covered by military security restrictions.

Engineering efforts to stop the cost of space vehicles from rocketing as high as their payloads were outlined. One method is to recover and re-use the expensive booster rockets which fall back to earth as the main rocket rises into space.

H. H. Koelle, of the Army Ballistic Missile Agency, Redstone Arsenal, Ala., cited the two major considerations in manned space flight as crew safety and economic feasibility. In a projection of future costs of lifting a pound of payload into orbit, Mr. Koelle suggested that costs per unit weight might be cut from something over $1 million in 1957 to about $1000 by 1960 and perhaps $100 by 1964. This improvement is expected to result from several combined influences; namely, increasing vehicle sizes, more powerful propellants, higher firing rates, and, finally, recovering boosters and re-using the recovered and rejuvenated hardware.

Among alternative methods of recovering boosters, said Mr. Koelle, are schemes using either parachutes, wings that convert the booster into a glider, or air-breathing engines to fly the booster back to its launching site.

In the near future at least, a simple parachute system in which relatively small brake rockets would first slow the flight of the exhausted booster before it lands in the ocean, might be most

Test pilots brief up before new style "space" venture. *Left to right,* R. C. Cokeley, Al Blackburn, Robert White, and Ollie Deal. Neal Armstrong, *standing,* checks the plot.

efficient. In part, this preference would be due to the cost, estimated as high as a billion dollars, to develop one of the more "sophisticated" methods involving wings or elaborate engines.

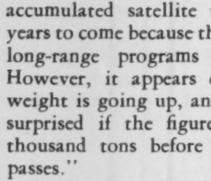
Tonnage in the Sky

Mr. Koelle said: "We have no choice but to look for means to reduce the technical and financial effort to send payloads into orbits about this planet and into deep space. A total of only two tons of useful payload has been placed into orbit during the past 12 months.

"It is very hard to estimate the total accumulated satellite weight over the years to come because there are no known long-range programs defined as yet. However, it appears certain that this weight is going up, and nobody will be surprised if the figure reaches several thousand tons before the next decade passes."

A paper from North American Aviation discussed the application of nuclear propulsion to satellite boosting. Among the conclusions was the observation that "while the use of any nuclear reactor creates a possible radiation hazard, there exists a radiation hazard in space itself, so that protection from both may not be much more of a problem than protection from either one."

Although early space vehicles may contain just one man and remain aloft only a few hours, later ones may be giant laboratories housing several individuals. Such units may be too large to ship after assembly, and may require manufacturers to develop methods of constructing them at the launching site.



Shrinking world or not—Toastmaster W. W. Reaser, Douglas Aircraft, starts luncheon on cue

Fitting Pieces Together

Existing missiles could boost whole sections of supersatellites into orbit. Once aloft, the sections could be joined together. A paper from the Martin Company described the possible procedure, the critical limiting factor being the ground-tracking system used to determine the orbit of the initial section. It should be possible to send succeeding sections into the same region with about the same orbits. Then would come a powered "rendezvous maneuver," followed by the "construction phase."

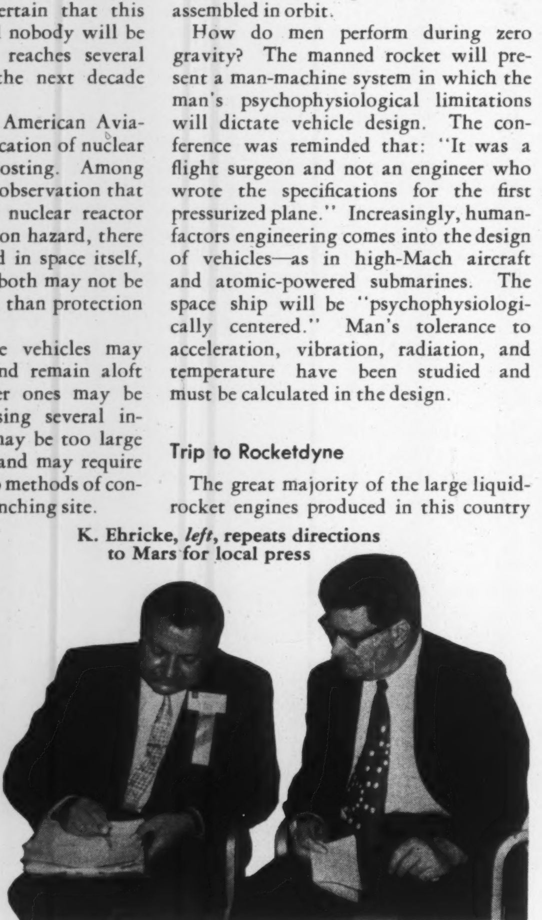
A paper from Aerojet-General discussed the construction phase. The authors gave as their opinion that the first true, manned space station will be assembled in orbit.

How do men perform during zero gravity? The manned rocket will present a man-machine system in which the man's psychophysiological limitations will dictate vehicle design. The conference was reminded that: "It was a flight surgeon and not an engineer who wrote the specifications for the first pressurized plane." Increasingly, human-factors engineering comes into the design of vehicles—as in high-Mach aircraft and atomic-powered submarines. The space ship will be "psychophysiologically centered." Man's tolerance to acceleration, vibration, radiation, and temperature have been studied and must be calculated in the design.

Trip to Rocketdyne

The great majority of the large liquid-rocket engines produced in this country are developed and tested on a 15-sq-mile test laboratory in the Santa Susana Mountains. Registrants at the conference had an opportunity to see the testing of rocket engines at this site, as guests of Rocketdyne. About 80 took advantage of this invitation, and they saw the running of three Atlas engines. A man who was there reports that "quite literally, the mountains tremble."

K. Ehricke, *left,* repeats directions to Mars for local press



There were two luncheon meetings in addition to the banquet. The first luncheon, with W. W. Reaser of Douglas as toastmaster, heard William Littlewood, vice-president, Equipment Section of American Airlines, discuss the operation of the new jet transports. The great carrying capacity of the new planes will actually reduce the number of planes which his line will have in service for the next few years.

Cabins are quiet, of course, but curious sound effects occur due to the noise pattern located in the after-disturbance of the jet exhaust. A minor earthquake seems to occur when the landing gear is lowered. Serious consideration has been given to an announcement to passengers, "Big noise about to come."

Mr. Littlewood sees three major changes needed for future flight patterns: "Isolation" for the military; "segregation" for private planes; "juxtaposition" for air transport and the centers of population served by them.

At the panel-discussion luncheon, A. W. Blackburn, president of the Society of Experimental Test Pilots, blasted at "Maginot Line" thinking, the missile arsenal that will be fueled with solid propellant and buried in the ground.

"Relax into a static posture," he said, "and we invite the flanking move as through Flanders, or the embarrassment of a Singapore where the big weapons were directed where the enemy was not."

He decried the public fascination with theoretical supercapability. We need a dynamic system—manned bomb carriers, capable of alternate routes to the target and last-minute switches to alternate targets.

In spacecraft too, he said, "The system which will most expeditiously accomplish man's conquest of space will be one that takes maximum advantage of the unique capabilities of man as a pilot."

Banquet

R. B. Dillaway, engineering group leader of Rocketdyne and General Chairman of the Conference, was toastmaster at the banquet which was held in the Statler's Pacific Ballroom. In the absence of Mr. Warren, President of the ASME, who was unable to attend, Mr. Dillaway introduced the main speaker, Rear Admiral John E. Clark, USN, Deputy Director, Advanced Research Projects Agency.

Admiral Clark based his remarks on the inescapable fact that we no longer have lengthy periods for readjustment change. Once, an "age" meant centuries. Now, the atomic of thermonuclear age, little more than a decade old, is already giving way to the space age. We have no time to pause and reflect. Reflection must be instantaneous and even anticipatory.

"When space breakthroughs can alter the balance of power in a matter of days," he said, "the nation must be . . . pledged to readiness to present and future. It cannot afford any other posture.

"Can this nation . . . proceed confidently and generously with long-term space research programs? If so, it will be buying the best kind of insurance for perpetuation of the American way of life."

A new National Aeronautics and Space Administration now is getting organized to pursue those of our national and international space programs which are purely scientific in character. On the other hand, the Advanced Research Projects Agency (ARPA) was established to plan and direct projects vital to our national security.

The ARPA

Admiral Clark reviewed the functions, objectives, and methods of ARPA. To date, the agency has been performing its work by assigning projects to one or another of the service organizations, or to other Government agencies. Since its inception on Feb. 12, 1958, ARPA has generated the major portion of our national space program.

He said: "We must digest the fact that the Russians are ahead of us because of our late start. We have the means to close the gap . . . if we can keep special interests and group rivalries under control. It will require fortitude in the face of more Russian firsts."

Availability List—Aviation Conference

The papers in this list are available in separate copy form until Jan. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

59—AV-1 On the Economy and Techniques of Large Booster Recovery, by H. H. Koelle

59—AV-2 Low-Thrust Transfer Between Circular Orbits, by E. Levin

59—AV-3 Power for Satellites, by J. H. Huth

59—AV-4 Dynamic Problems Associated With Satellite Orbit Control, by B. W. Augenstein

59—AV-5 Analysis of the Aerodynamic Heating for a Re-Entrant Space Vehicle, by M. J. Brunner

59—AV-6 Noise Control Measures for Jet Transport Operation, by R. J. Koenig

59—AV-7 The Martin-Denver Rocket-Missile Testing Facilities, by R. S. Williams

59—AV-8 Artificial "G" Fields—Perception of the Vertical, by J. T. Ray

59—AV-9 The Nuclear Submarine as a Manned Satellite Laboratory, by A. E. Hickey, Jr.

59—AV-10 Research of Human Performance During Zero Gravity, by E. L. Brown

59—AV-11 Environmental Control Systems for Manned-Space Vehicles, by R. A. Nau

59—AV-12 Environmental Requirements for Extended Occupancy of Manned Satellites, by S. H. Dole

59—AV-13 Psychophysiologically Centered Space-Vehicle Design, by A. J. Cacioppo

59—AV-14 Human Factors Design Requirements for Manned-Satellite Vehicles—A Survey of Equipment Requirements, by H. L. Wolbers

59—AV-15 Economic Considerations of Space-Flight Ground-Support Requirements, by M. A. Margolis and F. S. Pardee

59—AV-16 Recoverable Boost Vehicles With Air-Breathing Power Plants, by P. G. Kappus

59—AV-17 Propulsion Requirements for Space-Station Erection, by J. A. Bottorff and H. B. Ellis

59—AV-18 Problems Associated With Power Requirements for a Mars Mission, by J. H. Fisher and W. R. Menetry

59—AV-19 On-Site Loading of Solid Propellants for Large Missile and Satellite-Launching Units, by W. F. Haite

59—AV-20 Passenger-Seat Design as Applied to the Convair 880, by L. C. Beckett

59—AV-21 A Quarter Century of Aircraft Seating, by Stanley Lippert

59—AV-22 Integration of Maximum Comfort Into the Electra Passenger Seats, by G. E. Hanff

59—AV-23 Suitability of Solid and Liquid Rocket Engines for Placing Manned Satellites in Orbit, by Martin Goldsmith

59—AV-24 The Application of Nuclear Propulsion to Satellite Boosting, by W. A. Moser

59—AV-25 Problems Associated With the Assembly of a Multiunit Satellite in Orbit, by W. H. Clohessy and R. S. Wiltshire

59—AV-26 Simulation of Thermal Environment in Space, by J. B. Cladis

59—AV-27 The Penetration of Planetary Atmospheres, by Carl Gazley, Jr.

59—AV-28 A Proposed Criterion for the Selection of Forward and Rearward-Facing Seats, by I. I. Pinkel

59—AV-29 Some Radiator-Design Criteria for Space Vehicles, by J. P. Callinan and W. P. Berggren

59—AV-30 Mechanical Engineer's Solution for Noise Suppression, by H. W. Adams

59—AV-31 A Method of Determining the Transient Temperature Distribution in an Entry-Vehicle Heat Sink, by J. C. Tearnen

59—AV-32 Cesium-Ion Rocket Research Studies, by R. N. Edwards and Guntis Kuskevics

59—AV-33 Economics of Satellite Supply Vehicles, by Robert Cornog

59—AV-34 Designing for Human Capabilities Under Acceleration in Satellite Operations, by R. C. Kaehler, J. P. Meehan, and Toby Freedman

59—AV-35 Problems Associated With the Testing of Ion Thrust Chambers, by A. T. Forrester

59—AV-36 The Use of Aerodynamic Lift During Entry Into the Earth's Atmosphere, by Lester Lees, F. W. Hartwig, and C. B. Cohen

59—AV-37 A Photographic Study of Boiling in the Absence of Gravity, by R. Siegel and C. Usiskin

59—AV-38 The Design Characteristics of Inflatable Aluminized-Plastic, Spherical Earth Satellites With Respect to Ultraviolet, Visible, Infrared, and Radar Radiation, by G. P. Wood and A. F. Carter

59—AV-39 A Comparison of Long-Duration Secondary-Power Schemes for Space Vehicles, by A. P. Kelley

59—AV-40 Air Conditioning and Pressurization of the Convair 880 Turbojet Transport, by B. F. North

59—AV-41 Application of Variable Area Nozzle Refrigeration Turbine for Supersonic Aircraft, by L. Sawamura

59—AV-43 Positive-Displacement Hot Gas Motors for Auxiliary Power Units, by W. Patterson

59—AV-44 Technique of Temperature Prediction in Thermal-Lag Machines, by P. M. Mueller

59—AV-46 Comparison of Several Propulsion Systems for a Mars Mission, by R. S. Kraemer and V. R. Larson

59—AV-48 A Procedure for Designing and Testing Aircraft Structure Loaded by Jet Engine Noise, by A. L. Eshleman, Jr.

59—AV-49 Noise Suppressors for Avon and Conway Engines, by F. B. Greatrex

59—AV-50 The Reaction of People to Exterior Aircraft Noise, by L. L. Beranek, K. D. Kryter, and L. N. Miller

59—AV-51 Trends in Ground-Support Equipment for Surface-to-Surface Missiles Including Manned Satellites, by H. R. Hammond

59—AV-53 On the Generation of Noise by Turbulent Jets, by Alan Powell

59—AV-56 Logistic Support to Man's Ecology in Space, by J. E. Mangelsdorf

59—AV-58 The Handling and Transportation of Nuclear Fuels, by D. L. Hillis

Ventilation and Air Control as Production Factors Stressed at ASME Textile Conference

CHAIRMEN of meeting:
V. F. Sepavich,
Executive Committee

S. M. Watson, Arrangements;
J. A. McPherson, Jr.,
Program;

J. C. Cook,
Conference
General Chairman

NEW concern for and decidedly more stress on ventilation and the control of air as production factors in finishing plants were accented Thursday and Friday, March 12–13, at the Annual Textile Engineering Conference of The American Society of Mechanical Engineers. The conference was held at The Clemson House on the Clemson College campus.

The theme, "Trends in Textile Engineering," incorporated machinery review of the unconventional Saco-Lowell Magnedraft and Whittin Super-Draft systems.

Welcomed by Deans

Approximately 200 delegates were welcomed Thursday morning by Dr. James H. Sams, Mem. ASME, dean of Clemson's School of Engineering, and Gaston Gage, dean of the School of Textiles.

Appearing in the opening-day sessions, devoted to finishing topics, were Holmes W. Frederick, J. E. Sirrine Company, Greenville, S. C., "Trends in Finishing-Plant Ventilation"; J. L. Robinette, Lockwood-Greene Engineers, Spartanburg, S. C., "Modern Finishing-Plant Design"; B. R. Andrews, Jr., Mem. ASME, Andrews-Goodrich Division, J. O. Ross Engineering Corp., Dorchester, Mass., "Air Dryers and Curing Ovens"; and R. B. Chipman, General Electric Company, Charlotte, N. C., "Radiant Heat Drying."

Moderators were J. C. Whitehurst of J. C. Hunter, Inc., Greenville, S. C.; and A. D. Asbury, vice-president, J. E. Sirrine Co., also of Greenville.

Mr. Frederick predicted more totally enclosed hoods over equipment, winter ventilation with smaller quantities of air, and more fully air-conditioned areas.

Comfort and Health. He forecast also increased attention to heat-recovery equipment, better designed equipment, and protective coatings to reduce operating and maintenance costs, and more attention to air cleanliness and effective prevention of air pollution with the use of air filters. In general, industry seemed headed for "more comfort and health for the man at the machine," he said.

Noting the importance of removing excess heat and moisture in safeguarding against subsequent deterioration and damage to goods, Mr. Frederick outlined four procedures. They call for the removal of water vapor at its source, dilution of moist air with relatively dry air, heating the air and surfaces to a temperature above the dew point, and delivery of fresh air to hot areas to improve efficiency and comfort of workers.

Removal of moisture at its source, he said, is proving most logical. Normally it is accomplished by containing the water vapor in hoods and removing it by exhaust fans. The usual practice, he said, is to enclose completely tenter driers and ovens and often rope washers. Open washers, dry cans, and sanforizers have canopy-type hoods.

Totally enclosed hoods were cited for requiring less exhaust, protecting workers from heat, and making heat recovery more feasible. Axial-flow fans were recommended as more economical than centrifugal fans.

Air Versus Exhaust. Mr. Frederick detailed two methods for supplying absorption. Determined as more economical with greater flexibility is the use of smaller heating or ventilating units which discharge under the roof without ductwork. Providing the most ease of maintenance is the method of delivering air to the underside of the roof through ductwork by employing a large central station.

He stressed the need of greater amounts of air in a finishing plant than exhaust, which results in positive pressure and prevents cold air leakage into the building.

"It is unfortunately true," Mr. Frederick said, "that most plants today have more exhaust than supply capacity." Negative results in winter have included reduced effectiveness of fans and hoods, draft leaks, fogs, backdrafts in gas flues, and spreading of noxious fumes.

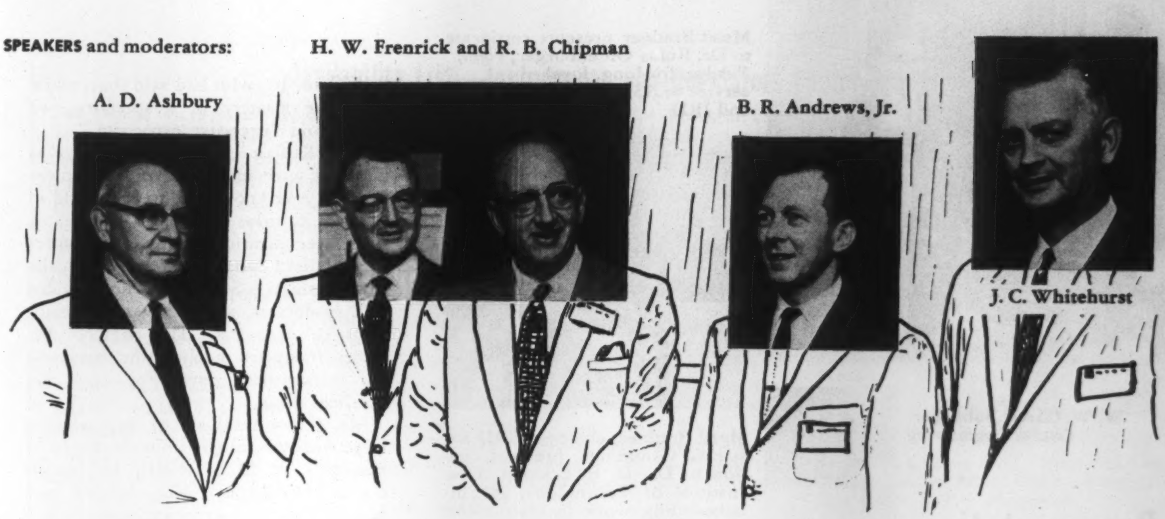
A Model Plant. Engineer Robinette, using what he called "the most up-to-date finishing establishments in the country" for illustration, elaborated on seven measures successful in the model plant. Praised was Kendall Company's bleaching, dye, and finishing plant—a U-shaped layout of 235,000 sq ft designed for a 120 million yd per-year capacity—at Bethune, S. C.

In this plant: all possible heat is trapped at points of generation with hoods; dye-house areas are surrounded by rigid drop curtains with fans drawing air out continuously; fresh-air-supply fans at roof levels filter incoming air; discharging into working aisles; unit heaters at ceiling are placed near shipping doors and controlled from floor, with exhaust fans in rear providing heat and ventilation.

Gray rooms, singeing, bleaching, and mercerizing areas, in this plant, have air-supply ceiling units for controlled heating. A central air-conditioning station is used in other areas where there is little or no heat from processing. The dye house, in addition to exhaust fans in high places, intakes fresh air through filters.

Factors in Design. Mr. Andrews related that the latest type of radiant pre-set treatment possible on new type air driers allows less migration and more level dyeing than previously obtainable.

SPEAKERS and moderators:



He said it is possible since gas is now available to most finishing plants. By this system, goods are exposed for a relatively long period to radiate heat from metal surfaces heated with air. Temperatures can be maintained at any predetermined amount.

Air-drier design should include, Mr. Andrews concluded: an air-delivery system that has the most efficient combination of nozzle spacing, orifice, and velocity; a fan and heating arrangement that uses maximum air hp permitted; and heating and maintenance of the air stream at the highest temperature dictated by the other factors.

On curing units, he said, practically all goods—except a few synthetics—are degraded by overdrying and overheating.

Heat-Control Solution. He advocated a curing process through which goods pass between ducts and nozzles in a manner similar to drying and continue through a holding section where the temperature of the fabric is maintained but not raised. This insures, he said, high resin retention with a short curing period and without overheating surface fibers. "Superiority of this type cure applies to all weights and thicknesses of goods," said Mr. Andrews, "but is most noticeable on heavier and thicker fabrics."

In answer to queries on the relative economy, Mr. Andrews said steam involved the lowest cost, followed by gas and electricity.

Mr. Chipman reported, on radiant heat drying, that the problems of even and uniform drying and heating can be solved by proper placing, and correct spacing, of wattage. "Heat control is the nub of the problem," he said, citing improvements in accuracy of control and ability to duplicate control conditions.

He said few dyeing plants have steam pressures high enough to reach cure box temperatures, ranging from 290 to 360 F, but electric radiant heat can supply these temperatures "with ease."

The final session, on Friday morning, heard papers on "Magnetic Drafting System" by Robert M. Jones, Mem. ASME, vice-president for research, and Virgil A. Burnham, chief research engineer, Saco-Lowell Shops, Biddeford, Me.; "Modern Spinning," by Carl Brandt, Whitin Machine Works, Whitinville, Mass.; "The Unifil," by Harry Kennedey, Universal Winding Company, Providence, R. I.; and "Shuttleless Loom," by F. M. Fitzgerald, director of research, Draper Corp., Hopedale, Mass.

Magnedraft Tests. Mr. Burnham stated that any fiber that could be run on the Duo-Poth frame system could be handled by Magnedraft. Merino and dacron polyester have been run with good results, but woolens have had limited success.

No large-scale mill installations have been made, Mr. Burnham related, but one-year tests have experienced only minor troubles. He reported that the experimental model had run for one year without traverse motion or buffing.

Buffing of Magnedrafts, eventually, will increase pressure of magnetic force. Roll pressure is between 15 and 16 lb. Fixed Almico magnets, with weight not adjustable, tend to be brittle but are protected by mounting in a tube of nonmagnetic material.

Mr. Brandt claimed accuracy in control, flexibility in handling cotton and spun synthetic fibers in lengths up to 3 ins. in explaining the Whitin Super-Draft.

Lubrication was reported no problem by Mr. Brandt. He described Super-Draft top rolls as antifriction in the front line, with nonlubricated rolls in the middle and back lines. Magnedraft uses no lubrication.

Reduced Quill Costs. The Unifil operation at the Woodside Corp. plant in Simpsonville, S. C., results in sharp reduction in quill replacement costs, said Mr. Kennedey.

Unifil adds little to the length of the conventional loom. Tests show it encounters no serious trouble on hard-to-strip yarns.

Draper's shuttleless loom produces less vibration but does not eliminate it entirely, according to Mr. Fitzgerald's paper. The filling contraction, he said, is similar to conventional looms but varies with the yarn count. No excessive yarn breakage has been noted.

"A Fair Shake"

Frank B. Bennett, Boston, president and executive editor of *America's Textile Reporter*, was guest banquet speaker Thursday night. He applauded the "individualistic" attitude of the textile industry and asked lawmakers to give it "a fair shake" in competition with "our foreign friends."

"The American textile industry," he said, "has gained in importance, throughout its history, without hand-outs from the federal government." He added, optimistically, that the industry is "slowly regaining its lost importance and thriving on friendly competition."

The conference was sponsored by the Textile Engineering Division of the ASME, with co-operation of the Greenville, South Carolina, Piedmont-Carolina, and Eastern North Carolina sections.

General chairman was Dr. J. C. Cook, head of the Clemson College mechanical engineering department. John A. McPherson, vice-president, The McPherson Co., Greenville, S. C., was program chairman; S. M. Watson, professor of mechanical engineering at Clemson, arrangements chairman.

Mead Bradner presents certificate to Dr. Rufus Oldenburger, *right*, Purdue, for long, loyal service to ASME and IRD

Mead Bradner, chairman IRD Executive Committee, presents citation to Dr. D. P. Eckman, Case Institute of Technology, for his outstanding work in instruments and regulators

W. W. Garey, publisher, *Control Engineering*

Documentation and Control Major Topics at ASME IRD Conference

The Instruments and Regulators Division of The American Society of Mechanical Engineers held its 1959 Annual Conference, March 30–April 1, at Case Institute of Technology, Cleveland, Ohio. The Conference was the fifth annual gathering held by the Division which was organized in 1943, and it was sponsored by the Division in co-operation with ASME's Cleveland Section. It was attended by some 150 scientists and engineers specializing in the field of instrumentation and automatic control.

Storage of Scientific Data

At the opening session, the conference heard a paper from the Center for Documentation and Communication at Western Reserve, on the storage and retrieval of scientific data, a problem of rapidly increasing importance in the world of engineering. Traditional library methods are giving way to nonconventional techniques for performing the operations of input, output, and "auxiliary conjunction," the latter being the means of maintaining consistency between input and output.

In succeeding sessions, all papers were strictly on control. Papers came from M.I.T. and General Electric, from Cook Technological Center and Borg Warner, from University of Wisconsin and Yokohama National University, from NYU, Baltimore's Research Institute for Advanced Study, and the University of California. The ultimate purpose of these investigations is steadier, more accurate control of processes.

Consider a complex control system consisting of numerous interrelated control loops: Attention has been paid to the possibility of achieving a total independence of the control loops. In theory, the problem is reduced to defining the adequate set of equations which give sufficient conditions for the independence of the control loops. In practice, achieving independence is possible only when the subsystems interchange relatively small power. One paper explained a method of consideration of complex control systems.

A paper from General Electric took up the problem of new thermoelectric combinations of metals for thermocouples. The purpose: To achieve the fast response required in aircraft jet engines. While it had heretofore been impractical or very difficult to determine turbine-inlet temperatures above 1600 F, a new system was described which is capable of measuring directly the most critical of all operational variables and accordingly allows safe potential increases in engine performance.

Faster airplanes pose increasing control problems. A new approach to necessary degree of control was offered by Otto J. M. Smith of the University of California.

Banquet

At the banquet, the main speaker was W. W. Garey, publisher of *Control Engineering*, who made the point that the engineer must see his work in the larger perspective. Mr. Garey quoted James R. Killian, Jr., who had said that, while achieving mastery of a specialty, we must avoid "excessive expertism."

"Dr. Killian," Mr. Garey said, "is pleading with men like you to explain and sell your knowledge to the world in terms of its value to society."

As specialization grows, it requires a specialized language. And then the trouble starts. Soon, only doctors can talk to doctors, artists to artists, engineers to engineers. The engineer becomes frustrated because the boss and the management don't appreciate his excellent ideas.

Mr. Garey recalled the day when a large sum was sought from the Board of Directors of McGraw-Hill to launch *Control Engineering*. Negotiations had bogged down in narrow expertism, when K. T. Compton, member of the board, spoke up.

"Gentlemen," he said, "we are witnessing the marriage of measurement to control. A happy union which will produce outstanding offspring, little short of phenomenal. There will be new industries, new processes, employing highly skilled people."

Loose phraseology? Not technically accurate? The fact is, it produced a true concept where expertism had failed. *Control Engineering* came into being.

Mr. Garey believes Henry Ford succeeded because he understood the broad purpose of what he was doing. Mr. Ford was not just building an automobile. (When he tried that, in the early days, he failed.) He was producing cheap, reliable transportation for people. Even bankers who did not believe in the automobile could understand that.

"With the increase in specialization," Mr. Garey said, "comes the urgent need to generalize your work in language and terms your customers will understand."

The speaker was introduced by J. A. Hrones, past-chairman of the Instruments and Regulators Division, and presently vice-president of Academic Affairs at Case Institute of Technology.

The Conference was under the direction of Mead Bradner of the Foxboro Company, chairman of the Division's Executive Committee. At the banquet, Mr. Bradner presented a citation to Dr. D. P. Eckman of Case Institute for his outstanding contributions to the research, literature, and teaching of instrumentation and regulation.

Mr. Bradner also presented a certificate to Dr. Rufus Oldenburger of Purdue for his long service to the ASME which includes the chairmanship of the Instruments and Regulators Division.

Availability List—Instruments and Regulators Conference

The papers in this list are available in separate copy form until Jan. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

59—IRD-1 A Thermocouple System for Measuring Turbine-Inlet Temperatures, by M. E. Ihnat and W. C. Hagel

59—IRD-2 Estimating the Roots of the Characteristic Determinant for Multicoupled Systems, by S. Lees, H. D. Felsenthal, and E. M. Goldberg

59—IRD-3 The Design and Analysis of a Servovalve With Flow Feedback, by E. Bahniuk and S. Y. Lee

59—IRD-4 Frequency Response of Multipass Shell-and-Tube Heat Exchangers, by Lewis Iscol and R. J. Altpeter

59—IRD-5 The Storage and Retrieval of Nonnumerical Data in Large and Complex Documentation Systems, by Allen Kent and J. W. Perry

59—IRD-6 Dynamic Response and Control of Multipass Heat Exchangers, by Masami Masubuchi

59—IRD-7 Human Body as an Inconstant Heat Source and Its Relation to Clothes Insulation; Descriptive Models of the Heat Source, by A. S. Iberall

59—IRD-8 Human Body as an Inconstant Heat Source and Its Relation to Clothes Insulation; Experimental Investigation Into Dynamics of the Source, by A. S. Iberall

59—IRD-9 Analysis of Electrohydraulic Pressure Control Servo-Valve Performance and Loads, by W. L. Kinney

59—IRD-10 Synthesis of the Strongly Interacting Control Loops, by M. D. Mesarović

59—IRD-11 On a New Approach to Filtering and Prediction Problems, by R. E. Kalman

59—IRD-12 Shannon's Theory and Feedback Systems, by S. S. L. Chang

59—IRD-13 Bang-Bang Versus Linear Control of a Second-Order, Rate-Type Servomotor, by P. F. Meyfarth

ASME Elects Ten to Grade of Fellow Member

The American Society of Mechanical Engineers has honored ten of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow, one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a Member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or Members of the Society to the Council, to be approved by Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

George A. Orrok

George Alexander Orrok, vice-president, Boston Edison Company, Boston, Mass., has made important engineering contributions in the field of power-plant design. His studies of metallurgical problems, as they pertain to high-temperature and high-pressure applications, led to numerous innovations. In 1945, as a result of these studies, the Boston Edison Company purchased the first reheat turbogenerator unit in the industry since the late 1920's. Today the use of reheat in units over 50,000 kw is almost universal. Mr. Orrok supervised the design of the first, and still probably the longest, high-pressure (1200 psi, 750 F) steam-distribution line in this country. With Boston Edison since 1930, Mr. Orrok assumed his current position in 1957. He had successively been an operating engineer and technical assistant; head of the mechanical and structural design division; and assistant superintendent and superintendent of the engineering department. In recent years, he has been largely responsible for the mechanical-engineering decisions in the design and installation of ten turbine-generator units in the company's generating stations. In addition, he has had the major responsibility for other construction work to meet the needs of the company, including underground cable and steam-line work, dock facilities, maintenance buildings, stores, and offices. He is the author of a number of papers on steam utilization, fuel savings, progress in the electric power industry, and such. Mr. Orrok is a member of ASCE; the Power Generation Committee of the Association of Edison Illuminating Companies; and a member of the National District Heating Association. He has been an active member of ASME on a local and national level. He served a three-year term on the Executive Committee of the Boston Section and for one year was its Chairman. He has served continuously on important technical committees including that on Condenser Tubes under the Research Committee and on various Power Test Code Committees. He is a registered professional engineer in the Commonwealth of Massachusetts, and is a member of Tau Beta Pi.

William A. Dundas

William A. Dundas, general superintendent, The Metropolitan Sanitary District of Greater Chicago, Chicago, Ill., is a recognized authority on the problems of modern sanitation. He has helped develop the Sanitary District's system into one of the marvels of modern engineering. In 1955, the Chicago system was named by ASCE as one of the Seven Modern Civil Engineering Wonders in the United States. He also headed the team which worked out the process that treats more than one billion gallons of waste water per day and disposes of the accumulated sewage solids. These plants prevent the pollution of Lake Michigan, the source of the drinking water for the Chicago metropolitan area. In addition to his command function, Mr. Dundas has been interested in a number of detail developments such as modern methods for disposing of sludge, equipment to make fertilizer from wastes, and modern techniques for dewatering and drying sludge. Mr. Dundas has been a member of the Sanitary District staff since 1919, and has been chief executive officer since 1947. He holds a number of patents pertaining to modern sanitation and has published many articles on the subject. He is the author of a book, "Dewatering of Sludge by Vacuum Filters in Combination With Heat Drying, Incineration, and Preparation for Fertilizer," published by ASCE. He has been an active member of the Chicago Section of ASME: has served on its Executive Committee and its Advisory Committee. He also is a member of Western Society of Engineers; is an honorary member of Pi Tau Sigma, and was one of the recipients of the 1958 Merit Award of the Alumni Federation of Carnegie Institute of Technology.

Henry H. Kerr

Henry Hamilton Kerr, retired vice-president and executive engineer, The Toledo Edison Company, Toledo, Ohio, is recognized for his career in electric-utility engineering. Mr. Kerr was among the first to promote the use of lignite in pulverized-coal firing of central power-plant boilers in Colorado, a practice that has been continued to this day in areas where lignite is readily available. He was a pioneer in the promotion and use of automatic substations in the transmission and distribution of electric energy. As the inventor of a system that interlocks the primary and secondary circuits on network transformers, Mr. Kerr has made important contributions to the safety of personnel and equipment, and the improvement of service. Mr. Kerr went to Toledo Edison in 1929 as superintendent of the electrical operating department. He was named general superintendent of engineering operation, maintenance, and construction in 1943; and in 1945 was appointed vice-president in charge of operations. He assumed the post of vice-president and executive engineer in 1953. His efforts in this capacity have included work with the Atomic Power Development Associates engaged in the development of a fast breeder reactor for the Enrico Fermi Plant. Mr. Kerr was for 20 years a member of the board of directors of Toledo Edison. He was named Engineer of the Year 1955 by the Toledo Technical Council. He is a fellow and a vice-president of the AIEE; a past-president of the Engineering Society of Toledo; and has been active in engineering development work with the Edison Electric Institute and the Association of Edison Illuminating Companies. He is a member also of the Toledo and Ohio Society of Professional Engineers. He has served the Toledo Section of the ASME as a member of its Executive Committee and as chairman of the Toledo Section. He is equally active in civic affairs and is currently president and trustee of Riverside Hospital; has been a member of the Toledo Chamber of Commerce, the Air Pollution Control Advisory Board; and he has played an important role in the development of the engineering school at the University of Toledo. He is a registered professional engineer in the State of Ohio. He is a member of Tau Beta Pi.

Karl H. Hubbard

Karl Hammond Hubbard, technical director in charge of research, Taylor Instrument Companies, Rochester, N. Y., is an authority in the field of industrial instruments and their application. From 1932 to 1945, Mr. Hubbard had taken out 20 patents on such items as regulators, recording sphygmomanometers, motor and air-operated control systems, and heat-exchange systems. He is coauthor of several papers published in technical journals. He has been with the Taylor Instrument Companies since 1928 when he joined them as head of the research division. Work under his direction included the scientific study of new and improved means of industrial temperature measurement and control. Other work included such instruments as aneroid barometers and medical instruments. He became chief engineer in charge of all product development and research in 1938. In 1953 he was named technical director in charge of research and adviser on major engineering and scientific subjects. He was made a director of the company in 1956; and a vice-president in 1957. He is a member also of the American Physical Society, the Rochester Engineering Society, and the Rochester Optical Society.

William W. Brown

William Wilson Brown, chief of Generation Division, General Engineering Department, The Detroit Edison Company, Detroit, Mich., is an authority on power-plant design and piping systems. His broad knowledge of power-plant equipment and engineering is highly regarded by engineers, manufacturers, and utility executives throughout the country. Mr. Brown joined Detroit Edison in 1923. Since that time, his efforts have been directed toward the simplification of design, improvement of efficiency, and reduction of costs for the company's new plants. He has been largely responsible for the engineering of the company's mechanical projects, including site selections, site development, plant layout, basic engineering, and economic studies. The River Rouge plant is among the many outstanding examples of these efforts. This plant is recognized as one of the most efficient, yet lowest cost plants in the country. His service at Detroit Edison has been continuous with the exception of the period 1943 to 1945, during which time he was Chief Construction Co-ordinator for electric utilities for the War Production Board, Office of War Utilities. In this capacity he was responsible for the solution of power-plant construction and equipment problems during the war. He reviewed the designs for both national and foreign power stations, making improvements directed toward reducing costs and minimizing equipment and material usage. His service to government agencies has been extensive. In 1946 he was with the Office of Emergency Control; from 1947 to 1948, with the National Security Resources Board; 1950 to 1951, director for the Defense Electric Power Administration; and from 1955 to the present, consultant, International Co-operation Administration. He is a member also of the Engineering Society of Detroit; of the Prime Movers Committee of the Edison Electric Institute; and a past-member of ASA Subcommittee B31. He is a registered professional engineer in the State of Michigan.

George W. Motherwell

George Washington Motherwell is a consultant and director of the Wyman-Gordon Company, Worcester, Mass. He is an authority in the field of forgings and the construction and operation of forging facilities. His accomplishments in this field have earned him world-wide recognition. Prior to joining Wyman-Gordon in 1941, he had conducted surveys of forging facilities in Japan, Germany, and England. In 1933 he was the mechanical engineer in charge of plant layout and construction of buildings for the Nissan Automobile Company, Yokohama, Japan. Here, he was in charge of installation of machinery and equipment as well as the training of personnel in die design, forging, heat treating, and product handling. He went, in 1936, to the Adam Opel Works, Division of General Motors Overseas, Russelheim, Germany. There, he presented a program to the German Government for approval of American production methods to improve the quality of forging used in European automobiles. From January to November, 1939, Mr. Motherwell performed a similar function at Vauxhall Motors, Ltd., Division of General Motors Corporation, Luton Beds, England. He then returned to the United States and was plant manager of the forge shop of the General Motors' Oldsmobile Division until December 1940. As works manager of Wyman-Gordon in 1941, he expanded production facilities for wartime production. Under his leadership, new buildings and equipment were erected and installed without the interruption of production; and monthly output was increased ten times. In December 1944, Mr. Motherwell was responsible for the introduction of the Air Force pilot plant for the research and production of large aluminum and magnesium forgings. At that time, this plant operated the largest hydraulic forging press, 18,000 tons, in the country.

It was chiefly through his guidance that the Heavy Press Program became a success. In addition to his duties at Wyman-Gordon, he was chairman of the Heavy Press Program during its formative stages. In 1951, he became a vice-president in charge of manufacturing at Wyman-Gordon. He is the author of a number of papers published in the *Transactions of the ASME*, Mechanical Engineering, and other technical journals. He has served the Society on the national level as a member of the ASME General Committee of the Metals Engineering Division; and has served on the Financial Committee of the ASME Worcester Section. He is a member also of ASM, ASTE, and WES.

Albert B. Sperry

Albert Francis Sperry, president and director Panellit, Inc., is a specialist in automatic-control engineering. Mr. Sperry organized Panellit, Inc., in 1943; and pioneered in the design and manufacture of central-control and data-reduction systems. In addition to being president of the firm, he has retained his interest in research, design, and development; and is responsible for many recent improvements in the fields of information handling and data reduction systems. His career in instrumentation began in 1923 in the research department of the Republic Flow Meter Company, Chicago, Ill., where he went on to design many process instruments and controllers. He became vice-president in charge of engineering and research in 1933. He organized the Hubbard Engineering Company, a firm of consulting engineers specializing in power-plant construction in 1937. During World War II he returned to the field of instrumentation, designing submarine diving gears, a monitoring system for the Atomic Energy Commission, and many instruments for the Air Corps and Signal Corps. He holds more than 50 patents on instruments and regulators of many types. He is the author of many papers published in the *Transactions of the ASME* and other technical journals. Mr. Sperry was active in the organization of the Instrument Society of America, was its first president in 1946, became a director in 1948, and in 1956 was made an honorary member. He is a member also of AAAS, AIEE, AMA, the Society of Instrument Technology (England), the Western Society of Engineers, and the board of trustees of FIER. He has served the ASME on many committees of the Process Industries Division. He was among the organizers of the Instruments and Regulators Division, formerly the Industrial Instruments and Regulators Division. He served as its chairman in 1951 and was active on a number of its committees. He has been a member also of several Research Committees. In 1950 the Instruments and Regulators Division presented him with an award citing him "for the elements which he has added to the mathematical structure of process control, for his aids to the operation of complex systems, and for his professional leadership and inspiration to others." He is a registered professional engineer in the States of Iowa, Michigan, and Illinois.

Wilfred Sykes

Wilfred Sykes, retired chairman of the executive committee, Inland Steel Company, Chicago, Ill., has had an outstanding career in the steel industry as an inventor and an administrator. His many achievements include the application of electricity to steel mills, the application of welding techniques to steel production, and the development of open-hearth-furnace control systems. Mr. Sykes joined Inland Steel in 1923, became assistant general superintendent in 1927, and assistant to the president in 1930. He was president of the company from 1941 to 1949, and in 1955 retired as chairman of the executive committee. He was directly responsible for the modernization program at Inland Steel which brought about an increase in ingot capacity from 1,200,000 tons to 3,500,000 tons per year. During World War I, while with Westinghouse Electric and Manufacturing Company, Mr. Sykes had charge of designing electrical equipment for the use of the Navy, including propelling equipment for battleships and submarines. During World War II he was a member of various government committees in connection with the operation of steel mills and wartime steel production. After the war, at the request of the U. S. Army, he visited Germany to report on steps necessary for rehabilitation of its steel industry. He is the author of a number of articles on the subject for rolling mills.

In 1950 Mr. Sykes received the Washington Award for his achievements. This top engineering award is sponsored jointly by AIEE, ASCE, ASME, AIME, and the Western Society of Engineers. He is a member of all of these societies but the ASCE. He is a fellow of the Royal Society of Arts. In addition to his many engineering attainments, he has contributed much time and interest in behalf of the Illinois Institute of Technology and the Glenwood Manual Training School. The Glenwood school provides a home and proper training for underprivileged boys. He has served the community also as a director, president, and senior counselor of the Chicago Association of Commerce and Industry. He was a member of the Illinois Post-War Planning Commission.

Fred H. Einwaechter, Jr.

Fred Henry Einwaechter, Jr., chief engineer, motive power and equipment, Baltimore and Ohio Railroad Company, Baltimore, Md., has made many contributions in the field of locomotive engineering. Among his many achievements is the design of a nonarticulated 4-4-4-4 steam locomotive with high-pressure watertube-firebox boiler using four small cylinders. This design reduced the number of heavy machinery parts and also the stresses. As a member of the Mechanical Advisory Committee, Railroads and Coal Companies, Locomotive Development Committee of Bituminous Coal Research, Inc., he contributed to the solution of many basic research problems involved in the development of a coal-fired gas-turbine locomotive. Mr. Einwaechter began his career in the railroad industry with the B&O in 1913 as an apprentice. He successively held positions as shop mechanic, mechanical draftsman, leading locomotive draftsman, assistant engineer, mechanical engineer, and, in 1946, assumed his current post. His engineering activities have also extended into the field of committee work. He has been a member and chairman, 1955, of AAR Joint Equipment Committee and was member, vice-chairman, and, since 1957, chairman of an AAR Committee on Locomotives. He serves the ASME as a member of the Railroad Division, General Committee. He is the author of a book, "Evolution of Passenger Train Cars," 1956. He holds six patents for such devices as adjustable brasses for driving boxes, retractable coupler, a buffer mechanism, and flexible staybolts for fireboxes.

Thomas A. Fearnside

Thomas Astley Fearnside, assistant engineering manager, Stone & Webster Engineering Corporation, Boston, Mass., is an acknowledged authority on power-plant design. His career has been contemporaneous with major developments in the art and science of steam-electric power generation to which he has made significant contributions. The adoption of higher steam pressures and temperatures in numerous industrial power plants paralleling advanced central station practice, has been accelerated by the successful performance of the many such projects for which he had the engineering responsibility. Among the important industrial power projects under his charge were power and steam plants for the Standard Oil Company of Louisiana, Baton Rouge refinery; for the Standard Oil Company of Indiana at both the Sugar Creek, Mo., and Whiting, Ind., refineries; and for the Texas Division, The Dow Chemical Company at both Freeport and Velasco, Texas. Major utility projects for which he has had engineering responsibilities include the installation of four 100,000-kw steam-turbine generators at Richard L. Hearn Station, Toronto, Canada, for the Hydro Electric Power Commission of Ontario. During World War II, Mr. Fearnside was responsible for the engineering in connection with an important portion of the U. S. A. Manhattan District Project at Oak Ridge, Tenn. His affiliation with Stone & Webster began in 1940. Prior to that time he was employed by the Johns-Manville Sales Corporation, Boston, Mass., and the International Silver Company, Meriden, Conn., in a nonengineering capacity. From 1937 to 1939, he was with The Babcock & Wilcox Company, Proposition and Contract Division. Mr. Fearnside is coauthor, with F. C. Cheney, of a paper, "Industrial Power Plant Costs," published in *Combustion;* and has presented other papers before meetings of technical societies. He has served the ASME as chairman of the Boston Section in 1946. He is a member also of the National Society of Professional Engineers. He is a registered professional engineer in the States of Massachusetts, Michigan, New York, and New Hampshire.

ASME COMING EVENTS

May 4–5

ASME Maintenance and Plant Engineering Conference, Edgewater Beach Hotel, Chicago, Ill.

May 11–13

ASME, AIEE, IRE Automatic Techniques Conference, Pick Congress Hotel, Chicago, Ill.

May 12–14

ASME Production Engineering Conference, Statler-Hilton Hotel, Detroit, Mich.

May 25–28

ASME Design Engineering Conference, Convention Hall, Philadelphia, Pa.

June 1–3

ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting, Palliser Hotel, Calgary, Alberta, Canada

June 8–12

ASME, AMHS, SAM Materials Handling Conference, Cleveland Auditorium, Cleveland, Ohio

June 14–18

ASME Semi-Annual Meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

June 18–20

ASME Applied Mechanics Conference, Virginia Polytechnic Institute, Blacksburg, Va.

August 9–12

ASME-AIChE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

September 9–11

ASME Applied Mechanics Western Conference, Stanford University, Stanford, Calif.

September 10–12

ASME, AIChE, FPRS Wood Industries Conference, Multnomah Hotel, Portland, Ore.

September 17–18

ASME-AIEE Engineering Management Conference, Statler Hilton Hotel, Los Angeles, Calif.

September 20–23

ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas

September 27–October 1

ASME-AIEE National Power Conference, Hotel Muehlebach, Kansas City, Mo.

October 20–22

ASME-ASLE Lubrication Conference, Hotel Sheraton-McAlpin, New York, N. Y.

October 26–29

ASME-AIME Fuels Conference, Netherland Hilton Hotel, Cincinnati, Ohio

November 4–6

ASME-IRE-AIEE-ISA National Automatic Control Conference, Sheraton Hotel, Dallas, Texas

November 8–13

ASME, ASTM, ACS International Rubber Conference, Shoreham and Park Plaza Hotels, Washington, D. C.

November 16–20

ASME Materials Handling Conference, New York Trade Show Building, New York, N. Y.

November 29–December 4

ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N.J.

(*For Meetings of Other Societies, see page 110*)

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N.Y., for which there is no charge providing you state that you are a member of ASME.

PEOPLE

Honors and Awards. M. E. Merchant, Mem. ASME, has been named the recipient of the 1959 ASLE National Award. The award symbolizes an honorary life membership in ASLE and is awarded in recognition of an outstanding contribution in the field of lubrication.

Robert M. Page, director of research, U. S. Naval Research Laboratory, Washington, D. C., has received the third annual Captain Robert Dexter Conrad Award established by the Office of Naval Research. Dr. Page has made distinguished contributions in research and development for the Navy.

New Appointments. Vice Admiral Edward Lull Cochrane (U. S. Navy, ret.), Hon. Mem. ASME, has been appointed chairman of the Division of Engineering and Industrial Research, National Academy of Sciences.

Allan Ray Putnam has been appointed managing director of the American Society of Metals. Mr. Putnam had formerly been assistant executive secretary of the American Society of Tool Engineers.

Rolland S. Stover, former Vice-President, ASME Region VI, was elected president of the Midwest Gas Association. Members of the association handle the distribution, transmission, and production of natural gas in seven states.

Arthur H. Senner, Mem. ASME, has joined the faculty of the Baltimore Polytechnic Institute, Baltimore, Md. Mr. Senner has recently retired from 38 years of government service with the U. S. Naval Engineering Experiment Station, Annapolis, Md.

New Officers. C. L. Kent, assistant director, technical services division,

Blackall Machine Tool and Gage Award Presentation in London. S. A. Tobias, *left,* assistant research director, Engineering Department, Cambridge University, and Wilfred Fishwick, *center,* professor of electrical engineering, University College of Swansea, recipients of 1958 award. F. S. Blackall, jr., *right,* past-president and Fellow ASME, for whom the award is named, makes presentation. Dr. Tobias and Professor Fishwick received Blackall award for their paper, "Chatter of Lathe Tools Under Orthogonal Cutting Conditions." The award is conferred annually for the best paper submitted to ASME on a subject clearly concerned with or related to the design or application of machine tools, gages, or dimensional measuring instruments. Official presentation ceremony was held at The Institution of Mechanical Engineers, March 20, 1959.

Jones & Laughlin Steel Corporation, Pittsburgh, Pa., and R. J. Stuart, Vascoloy-Ramet Corporation, Waukegan, Ill., were recently appointed to the American Standards Association, Standards Council.

Edward Wegelius, National Technical Research Institute, Helsinki, has been named the new president of the International Organization for Standardization. He succeeds Sir Roger Duncalfe.

Cecil Boling is the new president of the recently formed American Society of Heating Refrigerating and Air-Conditioning Engineers. The society was formed through the merger of the American Society of Heating and Air-Conditioning Engineers with The American Society of Refrigerating Engineers.

A. C. Blackman has been named managing director of the American Society of Safety Engineers. Formerly, he headed California's Division of Industrial Safety.

Campus Data. John W. Graham, Jr., currently vice-president of The Cooper Union for the Advancement of Science and Art, New York, N. Y., has been named as the first dean of the new College of Engineering at the University of Rochester.

H. Maurice Carlson, head of the department of mechanical engineering, Lafayette College, has been named director of engineering for a three year term to begin Aug. 31, 1959.

Died. Wilhelm Spannhake, professor emeritus, Technische Hochschule, Karlsruhe, died Jan. 21, 1959. Dr. Spannhake was a leading figure in the field of turbomachinery. He was noted in this country for his work at M.I.T. in the early 1930's, and at the David Taylor Model Basin and the Illinois Institute of Technology Armour Research Foundation after World War II.

Management Must Catch Up With "Exploding" Technology, W. F. Rockwell, Jr., Tells American Power Conference

Business management must catch up with "exploding" technology if policy-makers are to make sound decisions, W. F. Rockwell, Jr., Mem. ASME, president of Rockwell Manufacturing Company, told the opening session of the 21st American Power Conference, Tuesday, March 31, at the Hotel Sherman in Chicago, Ill. He warned the gathering of power engineers, "Management people in business and government need a far greater understanding of technology than they now have."

Management Must Catch Up. "Bankers, lawyers, politicians, and other nontechnically trained mangement people are called upon to make decisions without sufficient background to take adequate account of their technical environment," he continued.

"We have not begun to prepare for technological progress as the day-to-day fact of life which it has become," Mr. Rockwell said. "Prior generations did not live through rapid successions of technological accomplishments that have added formerly strange words like television, satellite, and polyethylene to our everyday vocabularies." He pointed out that management is now flooded with new data everyday on "throughputs," "neutron flux density," "value analysis," and similarly complex technical concepts that mean nothing to the layman without technical orientation.

Mr. Rockwell declared that 90 per cent of present knowledge has been gained in the past 50 years. "And mankind's general fund of knowledge is now doubling every 15 years," he added.

Calls Upon Educators. Complicating the exploding technology is the world's exploding population which makes technological progress essential. He pointed out that the annual net population gain in the United States is $2^1/_2$ million and in the world is 30 million. The concurrence of exploding technology and exploding population will place management in comparative technical dark ages if no formal program is launched for management to keep up with and get ahead of technology.

Mr. Rockwell said that technical courses in nontechnical schools are as important as humanities courses in engineering schools. He called on engineers and engineering educators to initiate courses in technology for undergraduate college students in nontechnical schools and for practicing management people. "Those in the best position to see the need," he warned, "must be the first to act."

Availability List—American Power Conference

The papers in this list are available in separate copy form until Jan. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

59—APwr-1 Ultrasonic Testing of Large Steam-Turbine Parts, by L. E. Smith

59—APwr-2 An Operating Report of the Monitored Sterlington Station, by Donald Aswell and George Parmakian

59—APwr-3 Large Steam-Turbine Generators for the 1960's, by E. H. Miller and B. M. Cain

ASME Moves Toward Unity

The American Society of Mechanical Engineers has taken a concrete step toward "unity of the engineering profession." In the future, members of the 21 sister engineering societies, represented on Engineers Joint Council or Engineers' Council for Professional Development, will enjoy the privilege of attending general meetings of ASME without registration fee. At conferences sponsored by any of ASME's Professional Divisions, they will pay the same fee as that charged ASME members, usually one half the nonmember rate.

In an accompanying statement, Glenn B. Warren, President of ASME, said:

"We hope that, by taking this initial step, ASME is helping to demonstrate the community of interests shared by all engineers and is helping to lead the way toward greater liaison at the working level. Clearly, many of ASME's national meetings are of interest to members of our sister groups. We hope that the adjustment of registration fees will encourage them to share in the benefits of these meetings and conferences. Although this step may result in some loss of income to ASME, we are confident that dollars spent in this way will pay dividends for the entire profession."

Engineering groups currently represented on EJC or ECPD, whose individual members are eligible for these privileges, are as follows: American Society of Civil Engineers; American Institute of Mining, Metallurgical, and Petroleum Engineers; The American Water Works Association; American Institute of Electrical Engineers; The American Society for Engineering Education; American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.; The Society of American Military Engineers; American Institute of Chemical Engineers; American Institute of Industrial Engineers, Inc.; The Engineering Institute of Canada; National Council of State Boards of Engineering Examiners; American Society of Agricultural Engineers; American Institute of Plant Engineers; American Institute of Consulting Engineers; Western Society of Engineers; Louisiana Engineering Society; Engineering Societies of New England, Inc.; South Carolina Society of Engineers; Los Angeles Council of Engineering Societies; Kentucky Society of Professional Engineers; and Consulting Engineers Council.

Members of The Institution of Mechanical Engineers of Great Britain and the American Rocket Society continue to be eligible for the same privileges under previously announced reciprocal agreements between ASME and those societies. Members of The Engineering Institute of Canada, represented on ECPD, have also been eligible for attendance privileges for some time.

ASME Survey of Undergraduate Heat-Transfer Teaching for Mechanical Engineers

A survey of undergraduate heat-transfer courses offered to mechanical-engineering students was conducted during 1957 by the Committee on Teaching of Heat Transfer, Heat Transfer Division of The American Society of Mechanical Engineers, under the direction of C. H. Coogan of the University of Connecticut. The primary purpose of this survey was to evaluate the teaching of heat transfer as an engineering science in the mechanical-engineering curriculum and to determine the likely direction which such programs would assume in the future.

Although the Committee realizes that any listing of curriculums covering the academic year 1956–1957 is likely to be somewhat outdated at this time, it is believed that the general results would still be of interest to ASME members.

Questionnaires were sent to all engineering colleges with ECPD accredited mechanical-engineering programs and 80 replies were received, representing the majority of the institutions canvassed. For purposes of analysis, a distinction was made in the questionnaire between the incidental teaching of heat-transfer applications as would occur in power-plant or air-conditioning courses and the systematic teaching of heat-transfer fundamentals in any course (irrespective of course title) provided at least $1^1/_2$-term credit hours were devoted to heat transfer.

The results of the survey are summarized in the accompanying table. More than half the responding institutions required at least a three-term credit hour (or equivalent) course in either the junior or the senior year. A first course in thermodynamics was a prerequisite in almost all instances, and a considerable number of schools also required a previous course in differential equations. Where heat transfer was offered as a senior course, fluid mechanics was frequently listed as a basic prerequisite.

Summary of Undergraduate Heat-Transfer Teaching in Mechanical Engineering —1957

Course Offerings	Number of Schools
Required Heat-Transfer Courses	
2 Term Credits or Equivalent	14
3 or 4 Term Credits or Equivalent	43
3 Term Credits Plus Senior Elective	2
Regular Electives	
2 Term Credits or Equivalent	1
3 Term Credits or Equivalent	10
No Heat-Transfer Course Offered or Less Than $1^1/_2$-Term Credits	8
Total	78
Textbook Used as of 1956–1957	
Brown and Marco, "Introduction to Heat Transfer," McGraw-Hill Book Co., Inc.	23
Jakob and Hawkins, "Elements of Heat Transfer and Insulation," Wiley	21
McAdams, "Heat Transmission," McGraw-Hill Book Co., Inc.	16
Giedt, "Principles of Engineering Heat Transfer," Van Nostrand	8
Others and Notes Only	5

The listing of "Regular Electives" includes courses which would be taken by a sizable portion of the mechanical-engineering student body and which may be required for certain ME options.

Course content followed, in general, the standard textbook coverage of conduction, convection, radiation, and heat-exchanger analysis, although transient conduction was omitted in some schools. Only in isolated cases was mass transfer incorporated as part of the course.

The 1956–1957 textbook requirements are also shown in the table (some schools indicated more than one required text). These listings should not be considered to indicate trends; the survey was carried out prior to publication of either Kreith's text or the revised editions of Brown and Marco and of Jakob and Hawkins, and during the first year of publication of Giedt's book. It should, however, be added that a relatively large number of respondents expressed dissatisfaction with the texts they used at the time of the survey and indicated a desire to switch to a more thorough or advanced undergraduate text as soon as it became available.

Most schools also listed separate heat transfer offerings in chemical engineering, either as a separate course or as part of a unit operations sequence. Approximately half the respondents listed heat transfer as an elective for nonmechanical engineers, although less than a dozen required such a course for either electrical or aeronautical engineers. Three schools indicated a separate heat-transfer course as a requirement in Electrical Engineering.

Additional information regarding this survey may be obtained by writing to Prof. F. Landis, Department of Mechanical Engineering, New York University, New York 53, N. Y.

ASME Committee on Teaching of Heat Transfer (K-15) includes the following: F. Landis, *Chairman;* K. N. Astill; C. H. Coogan; H. G. Elrod, Jr.; H. K. Hurwics; S. P. Kezios; E. B. Penrod; and W. M. Rohsenow.

Conducted for the National Junior Committee

A. S. GOLDSTEIN

JUNIOR FORUM

Professional Divisions and the Associate Member

By Earl L. Madison, Jr.[2]

How may I become active in the Professional Divisions of the ASME? This question has been asked by every mechanical engineer at one time or another, and the answers, if any, have been varied depending upon the sources of the replies. In recent months the "Junior Forum" has had a variety of articles about various functions in which Associate Members are participating. These have included "The Other Half," "Cincinnati Associate Members in Action," "Attitudes of Young Engineers," and "National Junior Committee Annual Report 1957–1958." In practically every instance these articles have made reference to the Professional Divisions.

Upon entering ASME the young engineer is requested to select the divisions in which he is interested and with which he wishes to be affiliated. Immediately upon this selection he has become active, but only to that extent to which he is willing to participate in the activities of these divisions.

Along about now questions are beginning to form in the minds of some who are not familiar with the divisional organization of ASME. (See "The Professional Divisions of the ASME: Their Scope and Activities," Mechanical Engineering, March, 1959, pp. 66–76.) Questions most frequently asked: (1) What is a Professional Division and what is its function? (2) How may I become active in ASME by participation in the Professional Divisions? (3) What have other young engineers done in the Professional Divisions? and (4) How may I benefit by participating?

What is a Professional Division?

Professional Divisions are formed to provide for the specialized professional interest of the members of ASME. This should not be construed to mean that these divisions are arbitrarily formed. The formation of new divisions is governed by the ASME Constitution, By-Laws, and Rules, Article R10, Rule 1, which states: "When a number of members of the Society interested in a particular branch of the work of the Society favor the formation of a Professional Division for that branch, they may draw up a petition for the establishment of such a Division. Each such petition shall be sent to the Professional Divisions Committee for presentation to the Council with its recommendation. Upon the approval of the petition by the Council, the Chairman of the Professional Divisions Committee shall appoint a temporary Chairman of the new Division." (See ASME Manual MM-1, Certificate of Incorporation, Constitution, By-Laws, and Rules.)

Earl L. Madison, Jr.

All Professional Divisions of ASME are under the supervision of the Professional Divisions Executive Committee. This committee co-ordinates and organizes the activities of the Professional Divisions and Groups within the Society. A Group only differs from a Division in size. The petition for a Division must be signed by at least 200 members; a Group is smaller. Example: The recently formed Human Factors Group which in time may grow into Divisional status. (See Mechanical Engineering, February, 1959, p. 127.)

The objectives of the Professional Divisions are stated in the ASME Constitution, By-Laws, and Rules, Article B10, Par. 1: "The object of each Professional Division shall be to provide, through an organization of members of any or all grades particularly interested in a branch of engineering included in the scope of the Society's activities, means for promoting the arts and sciences of that branch."

These objectives are carried out by the Professional Divisions through the review and presentation of technical papers during Divisional Conferences, joint engineering meetings, and the Semi-Annual and Annual Meeting of the Society. In many instances these papers are requested by a Division to bring to the forefront some new development or technological advance with which the members of the Society are not familiar. Thus the publication of technical papers is the means by which the founders of our Society have provided for technical communication. In addition, the divisions encourage research and development, and are responsible for the sponsorship of technical sessions and the publishing of related engineering data.

The scope of work within the Divisions often overlaps work being carried on by other Divisions within ASME and

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[1] Engineering writer, G. E. Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

[2] Nuclear engineer, Newport News Shipbuilding & Dry Dock Company, Newport News, Va. Assoc. Mem. ASME.

other engineering societies, which requires close association with these groups. Often joint meetings are given by two or more of the Divisions or with ASME and other societies participating in a joint meeting. In some instances a close relationship will exist between a Division and a Section due to a similar field of interest. In cases such as this, the Section often appoints a representative to act as liaison between the Division and Section. This type of activity is beneficial to both the Division and the Section. Such co-operation as this helps to bring new ideas and advances to the Division and ASME membership.

Active Divisional Participation

The question of how actual active participation can be accomplished is the hardest to answer. The answer will vary since each young engineer can best reply to what extent he is willing or capable of participation in the activities of the Society. There are many ways in which an engineer may obtain an active interest, such as submitting a technical paper, engaging in the activities of a Section with the Professional Divisions, corresponding with the National Junior Committee, and many others. However, the best method to "grab hold of the handle" is to step forward and express a desire and willingness to become more active.

The most direct approach to active participation is the preparation and presentation of a technical paper. (See ASME Manual MS-4, An ASME Paper.) In this manner a direct relationship can be established between the individual and the members of the Professional Divisions. The value of these contacts with the top engineers and executives within a particular field of engineering cannot be emphasized too strongly. Not only will the engineer benefit from the association with these men, but a more immediate return will be realized from the comments and suggestions produced as the result of the presentation of a technical paper. This type of participation would materially aid the young engineer in establishing a position for himself in the division, and a possible future appointment to a Divisional Committee.

The actual participation in Divisional Conferences and Meetings cannot be emphasized too strongly. Personal contacts and discussions at these sessions are one of the most valuable tools which an engineer has at his disposal. Invariably these discussions and after-hour get-togethers will lead to general "bull sessions" where new ideas and concepts are conceived. These sessions are ideally suitable as an outlet in which the Associate Member may voice his ideas and opinions, and at the same time may receive comments from some of the leading engineers in the field.

As previously pointed, some of the Sections work closely with the Professional Divisions. This relationship will conveniently allow the Associate Member, who is active in Sectional activities, to meet engineers within the Section who are closely associated with the Divisions. Many of the Sections have organized their programming activities along Division lines. The young engineer should avail himself of the opportunity of helping with this liaison work and activities within the Section. This could consist of helping to plan a divisional conference within the Section's area or actual correspondence with the Division through technical paper review.

Although the National Junior Committee is not a Professional Division, the corresponding with or actual participation in this committee is quite valuable to the Associate Member. In addition to actual membership in the National Junior Committee, an Associate Member may be recommended by NJC to act as a Junior Representative to certain Division and to other committees, such as the Professional Divisions Planning Committee, Publications Committee, or Meetings Committee. Through this type of activity the young engineer may obtain actual work experience with the Divisions which will greatly increase his knowledge of Society operation. This knowledge and association with committee members will be of great value in later years and may pave the way for a committee appointment. Many Sections such as the Cincinnati Section (see "Cincinnati Associate Members in Action," MECHANICAL ENGINEERING, December, 1958, pp. 129–130), have established Junior Committees within their own organization. The establishment of a similar committee in the Section would be a worth-while project for a group of young Associate Members.

Professional Division Encouragement

The role of active membership is not necessarily one which the Associate Member must accomplish by himself. Many Divisions and Sections encourage this participation and devote a great deal of effort in helping him obtain an active status. However, more should and can be done by each Division to insure active participation by Associate Members. A most effective method of accomplishing this is through Division newsletters.

The Divisional activities, current plans, and aspirations, so published, aid the young engineer in understanding the functions and organization of the Division. Personal contacts between Members and new Associate Members would materially aid in helping the young engineer to find himself within the Division and ASME.

Associate Action

Each associate should evaluate his present status within the Society to determine if, perhaps, he could do more to obtain a more active status within ASME, particularly in the Professional Divisions.

Where doubt may exist in the minds of some, it is suggested that the Associate Member contact his Section; the National Junior Committee; Society Headquarters in New York; or the Division of his choice.

It is hoped that the information presented in this article will help to provide the "handle" by which some of the younger engineers may obtain an active status in the Society. It will be through this active participation within the Divisions and ASME that the future strength of the Society and the profession will be assured.

Chairman's Corner

If you wish to become active on a National Committee of ASME, are under 30 years of age, and capable of attending a limited number of meetings in New York City and the Annual or Semi-Annual ASME meeting, write to Norman J. Viehmann, vice-chairman, National Junior Committee, Department 753, Western Electric Company, North Andover, Mass.

At the June meeting, the National Junior Committee will nominate Junior Representatives to the following national committees: Constitution and By-Laws, Professional Divisions, Publications, Meetings, Membership Development, and Gas Turbine Power Division.

If you should wish specific information concerning the qualifications and duties for any one of these appointments before expressing a preference, please write to either Mr. Viehmann or to:

William M. Morley, *Chairman*,
National Junior Committee, ASME,
Elliott Company,
226 South 16th Street,
Philadelphia 2, Pa.

ASME Spring Lubrication Conference Discusses Wear

The 133 members and guests who attended the second Spring Conference of the Lubrication Division of The American Society of Mechanical Engineers at The Franklin Institute, March 16 and 17, spent both an informative and enjoyable two days in Philadelphia. Three of the four sessions dealt with wear, which Oscar Bridgeman in his opening remarks defined as the removal of material as a result of motion between contacting parts. The influence of lubricants and additives on wear was considered in four different types of equipment—gears, diesel engines, hydraulic systems, and metal cutting tools; and the influence of design on wear was discussed with respect to (1) gears and (2) bearings in nuclear energy power plants. A trip through the laboratories of The Franklin Institute disclosed the extent of lubrication investigations that are being carried on at this research center.

The increasing use of radioactive tracer techniques in the investigation of wear was indicated by four of the papers presented. Victor N. Borsoff reported the results of wear studies on gears; and C. E. Trautman and H. A. Ambrose reported the effect of vanadium and sulfur on wear of diesel cylinders. Both of these wear studies used the radioactive tracer techniques. Two papers, one by R. G. Cunningham and B. H. Lambert and one by J. D. Jenks dealt with the techniques of wear measurements using radioactive tracers and the engineering of this method of investigation.

Problems involved in the lubrication of moving parts and bearings exposed to radiation energy were discussed in a paper by T. G. Chapman and a paper by N. Dewees. The Chapman paper dealt with the design of bearings to be lubricated by a slurry of water and thorium oxide. The Dewees paper discussed the design problems involved in bearings and other surfaces that are to be lubricated with high-purity water.

A most interesting motion picture was presented by M. H. Cocks which showed the action taking place between an unlubricated copper rider and copper drum. The pictures were taken through magnifying lenses and showed that a wedge of copper built up between the drum and the rider and prevented the rider from touching the drum most of the time.

Other papers included a discussion of wear and lubrication in metal cutting by Dr. A. Dorinson and a report by Dr. Smith on the use of the Vickers Pump as a means for investigating the influence of lubricants and additives on hydraulic pump wear. A paper by J. M. A. Van der Horst reported the measurement of potential differences between chromium-plated diesel cylinders and pistons and indicated that a test was now in progress in a marine engine having $21^1/_2$-in-diam cylinders. The use of wear-volume in the interpretation of results with the four-ball machine was suggested by R. S. Fein as a more accurate and informative method.

Professor Raynor's paper presented equations for determining oil flow in hydrostatically lubricated flat bearings, and shear breakdown of polymer thickners was discussed by O. C. Bridgeman. Charts and tables that are being included in a manual for the design of sleeve bearings were presented and described by H. Ripple of The Franklin Institute. This design manual is being prepared for the Bronze Bearing Institute.

ASME CODES AND STANDARDS WORKSHOP

American Standard Fluid Power Diagrams Published

By Kenneth Court, Chairman, Y14, Subcommittee 17

A drawing which depicts a hydraulic or pneumatic circuit for control or transmission of power differs in many ways from other engineering drawings. Its form varies with the type of components and the intended use of the diagram. Section 17 of the Y14 Drafting Standards Manual not only establishes drafting practices for fluid power diagrams, but also furnishes for the first time a comprehensive text and reference work. It explains in detail the data and notes which should accompany symbols and lines to make a diagram meet the requirements of engineering, sales, purchasing, and maintenance.

Diagrams are classified into four types:

1 *Pictorial Diagram* suitable for quotation and installation.

2 *Cutaway Diagram* used principally for instruction.

3 *Graphical Diagram* used extensively for design, quotation, installation, and analyzing circuit operation or malfunction.

4 *Combination Diagram* combining two or three of above types to emphasize a portion of a system.

Section 17 incorporates symbol data from "Graphical Symbols for Fluid Power Diagrams" (ASA Y32.10-1958) to make the graphical diagram the most versatile method of presenting fluid power diagrams.

Several examples of complete diagrams of each type are included. The examples include Sequence of Operations, Functional Description, Component List, Solenoid Chart, and other notes which are a necessary part of a complete fluid power diagram.

Copies are available from the ASME Order Department, 29 West 39th Street, New York, N. Y.

Addendum to Code for Pressure Piping

An addendum has been published and is available bringing up to date the List of Standards and Specifications in the Code for Pressure Piping (ASA B31.1-1955). The Addendum supersedes the Appendix to Sec. 7 on p. 134 of the Code.

The Addendum was sent to all subscribers to the Code for Pressure Piping Interpretations Service, and will be included automatically in copies of the Code when sold in the future. It is also available without charge, upon request to the ASME Order Dept., 29 West 39th St., New York 18, N. Y.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	57 Post St

Men Available[1]

Design or Production Engineer, BSME; 34; (*a*) Designing engineering layouts in coldforming machinery; calculations strength of materials, gears, transmission, weldment assistant, cam and linkages; foreign correspondence; four years apprenticeship. (*b*) Design engineering layouts threading machines, die heads, mechanism, one year. Me-705.

Project Engineer and Manager, BS (ME), MBA (Mgmt); 32; eight years' engineering and supervisory experience aircraft gas turbines thermoaero design, test, development. Looking for general management or engineering position where ability in planning, organizing, directing a specific project can be demonstrated. Location immaterial. Me-706.

Management Engineer, BAME, BSIE, PE; 36; 12 years' experience organization planning, methods, systems, procedures, layouts, incentives, scheduling, cost reduction. Production and office experience. Prefers N.J.-New York Metropolitan area. Me-707.

Executive Assistant, Sales Management, BSME and Civil Engineering; 40; 15 years' administrative, engineering, and sales experience on pumps, diesel engines, and electrical machinery, in foreign and domestic markets heavy machinery industry; outstanding market and personnel development record. Location immaterial. Me-708-939-Chicago.

Factory Manager, BME, P.I.E.; ten years' experience industrial engineering and management. Light manufacturing, assembling, and material handling. Presently chief industrial engineer and staff to general manager. Desires direct responsibility. Me-709.

Administrative Engineer, BME, MBA; 28; over four years' experience in engineering, research, and administration; machine design; advance manufacturing engineering; production engineering; analysis of financial and operating data, budgets, costs, and management audit of production areas. Prefers Chicago area. Me-710-941-Chicago.

Engineering Management, MSME; 29; administrative engineer, registered. Diversified and successful background in product engineering—medium construction equipment, test equipment. Much administrative experience, customer contact. Fine record in human relations; cost-conscious. Seeks challenging and responsible managerial position with small or medium manufacturer. Growth potential a must. Location immaterial. Me-711-943-Chicago.

Professor and Head of the Department of Mechanics and Electricity, PhD; 42; excellent record in teaching and engineering. Will organize engineering education, build laboratories. Speaks foreign languages. Me-712.

Design Analyst Engineer, BSME; 33; five years load, stress and vibration analysis of aircraft components—frames, landing gears, mechanisms; two years design analysis of missile-launchers. Prefers southern New England or N.Y. Me-713.

Mechanical Engineer, PhD expected; 37; ten years' college teaching and industrial experience in thermodynamics, heat transfer, fluid flow, and machine design. Me-714.

Superintendent of Maintenance, BS Kings Point; 35; 15 years' experience in maintenance and operation of power plants and buildings. Possesses N.Y.C. Stationary Engineer's license; refrigeration license; marine engineer's license, steam and diesel. Prefers East. Me-715.

Heat Transfer, R&D, BME, MS, one year toward PhD; 28; Peruvian citizen, fluent Spanish, English, some French; two years's experience as heat-transfer design engineer, two years as petroleum engineer. Prefers East or West Coast, Foreign. Me-716.

Product Designer, BSME; 40; 18 years' experience in product design and development; sales and customer plant layout, purchasing, shop and shop supervision, installations, and service. Accustomed to working, traveling, and taking responsibility. Location immaterial. Me-717-946-Chicago.

Engineer, plant engineering and food industry experience; BS, MS, EE, P.E.; ASME, AIEE, NSPE. Building and equipment engineering and maintenance. Development and application of automatic control systems. Capable executive and administrator. Me-718.

Chief Engineer, Production Manager, Heavy Mechanical Equipment, Machinery; 37; engineering six years—senior design, including customer liaison and relations, subcontracts; steel fabrication and machinery two years—field engineer, new equipment installation, maintenance of machinery; oil production. Four years design, sales oil-field equipment. One year instructor, mechanical drawing, analytical geometry thermodynamics. Prefers southern Calif. Me-1135-San Francisco.

Sales, Design, Aircrafts, Research Laboratory Engineering; 27; ME, Business Administration. One half year production design, analysis of propellant utilization, and heat-transfer problems of missiles. Two years research assistant special machining process, test of undersea warfare devices (part-time). Two years Army. One and one half years salesman and accountant, airconditioning, heating, and ventilating equipment. Prefers Southwest, Foreign. Me-1370-San Francisco.

Chief Designer, Project Supervisor, Electromechanical; 46; BS Forestry. Three years senior design on missile, ordnance-vehicles manufacture. Two years chief engineer on toy, juvenile wheeled goods, and lawn-furniture manufacture. Five years project engineer, supervising production design of ordnance-equipment manufacture. Four years assistant chief draftsmen on home-laundry-product development. Five years chief draftsman process-heating and cooling equipment, liaison. Five years design automotive clutches, product, and tool design. Prefers San Francisco Bay area. Me-1393-San Francisco.

Industrial, Process, Production, Development, Tool, Metal Working, Research; 33; MS(ME). Two years industrial engineer, production planning, control of tooling and tool design; manufacturing three years, junior process engineer, design of mechanical and hydraulic-test equipment, reports, special machinery for production. Two years tool designer for manufacturer. One year drafting, design for research institute. Prefers Foreign. Me-1508-San Francisco.

Manager, Production, Project, Metal Fabrication, Equipment; 39; ME; four years supervising reliability program design of missiles; design of pressure vessel and fuel-handling facilities on atomic reactors; product design on electronic computers. Two years assistant chief engineer on design of heat exchangers, pressure vessels, and miscellaneous process equipment. One year research on aircraft machinery. Six years project engineer, design, for manufacturer of chemical processes. Prefers San Francisco Bay area, New England. Me-1529-San Francisco.

Chief, Assistant, Design, Development, Supervisor, Machinery, Cranes; 72; ME. Five and one half years design overhead, gantry traveling cranes, conveyers; manufacturer four months, design of special pumps and meter accessories. Five years chief engineer, supervising development of electric mine hoists, ore cars; mining machinery manufacturer. Two years design pilot production units, fission-effecting assemblies; research laboratory. Prefers San Francisco, East Bay. Me-1569-San Francisco.

Positions Available

Sales Engineer, mechanical graduate, field-sales experience covering textile, knitting, and finishing machinery. Considerable travel in northeastern U.S. $8000, plus bonus. Headquarters, New York, N. Y. W-7195.

Engineers. (*a*) Assistant general manager for

Engineering Societies Personnel Service—San Francisco Advisory Committee elects officers during national AIME Convention in San Francisco. *Left to right, seated:* L. A. Norman (AIME); E. O. Kirkendall, president, ESPS national board of directors and executive secretary, AIME; B. L. Raffin (ASCE), vice-chairman; H. N. Appleton, director, ESPS and assistant secretary, AIME; R. M. Stewart (AIME), treasurer; *Standing, left to right:* J. R. Decker, ESPS western representative; C. K. Lewis (ECSF), assistant treasurer; Eric Salo (ASME), secretary; M. W. McLaren (AIEE), assistant secretary; H. N. Skow (AIEE); A. B. Sabin (CSPE); N. D. Cook, ESPS manager.

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[1] All men listed hold some form of ASME membership.

a printing firm of about 120 employees. Must be able to develop qualities of top executive. Excellent opportunity for advancement. $12,000–$15,000. (*b*) Assistant works manager with printing experience, able to supply leadership, direction, and all industrial-engineering qualities in plant. W-7202.

Teaching Personnel. (*a*) Instructor or assistant professor in engineering graphics. Instructorship will carry privileges of fulfilling requirements for a master's degree at the rate of up to nine credits a year. (*b*) Assistant or associate professor interested in teaching kinematics, mechanics of machines, machine design, and allied courses. At least master's degree required. Upstate N. Y. W-7203.

Product Engineer on Instrument Charts, engineering graduate, for work involving specifications covering the technical details of chart layout, printing, and plates for same; should be able to write purchase specifications for chart paper and supervise quality control. Some familiarity with paper and printing helpful. Salary open; company will pay moving expenses. New England. W-7204.

Senior Engineer, managerial and project-engineering experience in mechanical, civil, and geological fields, to make comprehensive surveys and prepare project-feasibility reports. $17,500. West Pakistan. F-7206.

Safety Engineer, degree in mechanical, chemical engineering, minimum of five years' experience. Must have good chemical-plant experience as a safety administrative engineer. $9250-$12,000. New York, N. Y. W-7207.

Assistant Chief Mechanical Engineer, graduate to take active charge of mechanical department of consulting-engineering firm. Must be experienced in industrial air conditioning as well as heating and ventilating. Experience in government contracts desirable; also small steam plants. P.E. license required. W-7211.

Vice-President and Director of Research, broad technical education, preferably a PhD for a very large manufacturer of a wide variety of industrial products. Must be a well-trained scientist, have a solid technical background and broad research experience. Familiarity with the newer technologies desired and he should be well known in scientific circles. Will be responsible for direction of all research facilities and for administering a widely varying, highly technical program of applied research. To $60,000, depending on past earnings and experience. Fringe benefits. East. W-7214.

Project or Contract Manager, mechanical or electrical graduate, project, estimating, and military-liaison experience covering electronic equipment. Must be familiar with government specifications, correspondence, and application engineering. $10,000-$12,000. N. J. W-7229.

Valve Engineers for Design and Development, graduates, from two to ten years' design and development experience, preferably in the field of fluid mechanics, including some pressure-vessel design. Salaries open. Various locations throughout the United States. W-7230.

Designers, at least a BS in mechanical engineering, with a minimum of one year's experience with products such as steam turbines, centrifugal pumps, compressors, or various kinds of gears. Should be especially good in mathematics, mechanics, and machine design. Must be able to compute design calculations and figure vibrations, stresses, critical speeds, etc. Salary open. N. J. W-7231.

Engineers. (*a*) Manufacturing engineer, BSME, background in planning, methodizing, and operation-sheet writing on machining and assembly operations on precision electromechanical devices. Experienced in tooling and estimating for small quantity runs' $8,000-$10,000. (*b*) Technical writers with three to four years' experience in writing and editing technical manuals and handbooks for electromechanical instrumentation and equipment. Thorough familiarity with MIL specifications. To $7800. Long Island, N. Y. W-7236.

Design Engineer, approximately five year's product-design experience, for design and development of new products and redesign of existing products covering pressure gages, pressure-testing equipment, pneumatic pressure and temperature-actuated transmitters, and allied equipment. Salary open. Apply by letter giving complete details including salary earned. Must be U.S. citizen. New England. W-7237.

Supervising Engineer, Maintenance, for a large medical center. Plant-engineering experience in chemical industry desirable; must be familiar with mechanical, electrical equipment and alterations. Permanent. Salary open. Pa. W-7242.

Manager of Power Production, graduate mechanical, experience in steam and hydroelectric plants and ability to analyze, co-ordinate and supervise work of the department. $11,000. South. W-7243.

Mechanical Engineer, graduate, for plant-engineering department. Minimum of two years experience, some of which should have been in the fields of chemical and packaging processing. Apply by letter giving complete information as to marital status, work experience, education, and starting salary desired. Fla. W-7250.

Machine Designer for a firm of engineers and fabricators operating in a variety of industries; mature, creative-board designer capable of developing ideas to successful machines and equipment. Must know how to design for economical shop practices. Approximately $10,000, plus profit sharing; will pay relocation expenses and placement fee. Va. W-7251.

Project Engineer for project cost control, plant, and equipment layout; detailed mechanical drafting and design, economic studies, materials-handling design, structural steel design, and supervision of draftsmen. $6500-$9000. Md. W-7252.

Project Engineer, Cryogenics, graduate mechanical, minimum of eight years' experience with the design of low-temperature refrigeration systems as applied to environmental simulating equipment. Must be capable of originating and supervising design of environmental chambers capable of operating at temperatures to 300 F. Should have had some supervisory experience. $9000-$10,000. Conn. W-7259 (*a*).

Design Engineers. (*a*) Senior mechanical design engineer, graduate mechanical, minimum of five years' experience in the design of environmental simulating equipment. Must be thoroughly familiar with and capable of solving the structural and thermodynamic problems related to extreme high and low-temperature simulation as well as a working knowledge of equipment and chamber-design details required for producing ultra high vacuum environments. $8000-$9000. (*d*) Mechanical designer, BSME preferred; five years' experience with board design of mechanical machine parts and/or electromechanical devices. Must be capable of original design work as applied to machine-design projects. $6240-$7280. Conn. W-7260.

Plating Engineer, thorough technical knowledge of plating solutions and procedures with a heavy background in chrome. Will be responsible for supervision of all phases of plating department including design of complicated fixtures, selection of new procedures where applicable, and training and supervision of personnel. At least five years' previous experience in the afore-mentioned and related education required. Salary open. Md. W-7262.

Chief Engineer, Industrial Gas Cleaning, graduate mechanical or electrical, at least ten years' experience in gas-cleaning engineering or related fields such as the power-plant industry. Must have had engineering administrative experience in the gas-cleaning field. Responsibilities include management and direction of functional, mechanical, structural, and electrical design, field test and service, application and development of all gas-cleaning products. Advanced degree preferred but not essential. $15,000-$18,000. East Coast. W-7263.

Manager Customer Service, Sales, graduate engineer, to direct customer-service section to obtain optimum effectiveness of all inquiry and order service activities. Analyze profitability of products and maintain, analyze, and disseminate competitive information and recommend appropriate action. Successful administrative, supervisory, and sales experience required. Technical education or experience preferred. $8400-$12,000. Md. W-7264.

Assistant or Associate Professor, preferably MS degree, to teach manufacturing and industrial engineering, i.e., materials and processing, metallurgy, methods, systems design. Background technical rather than management. To $6000 for nine months; possibility of consulting and summer activity. Conn. W-7265.

Engineers. (*a*) Assistant chief engineer, minimum of ten years' actual design and design supervisory experience on at least one of the following: Stationary compressors, gas boosters, military compressors and industrial air-cooled reciprocating compressors. (*b*) Product engineer, portable compressors, broad knowledge of mechanical engineering and machine-design fields. Seven to ten years' experience, preferably in problems concerning reciprocating and rotary compressor design. (*c*) Design engineer, thorough knowledge of machine-design field. Broad knowledge of good shop practices and erecting procedures. Must understand and interpret complicated drawings and specifications. Five to seven years' experience required. Midwest. W-7269.

Mechanical Engineer, BS or MS in mechanical engineering, at least two years' experience but will consider recent graduates with excellent academic records. Experience should be in mechanical equipment design and modification; helpful is experience with a continuous flow-type of process, e.g. oil or sugar refining, synthetic-fiber production. Depending on strength of background and interest, assignment could be in production semi-works operations, research pilot-plant studies or project engineering. From $6300 to $9600. Va. W-7275.

Chief Design Engineer, graduate, to head up large engineering design and drafting room for manufacturer of heating, ventilating, and air-conditioning equipment and direct design for production departments. $11,000-$15,000. Midwest. W-7278.

Engineers. (*a*) Chief estimator, heavy industrial plants, graduate mechanical or mining engineer, minimum of ten years' experience in estimating large industrial plants; including all mechanical, electrical, and civil engineering and construction for base metal plants, mills, concentrators, smelters, and refineries. Will supervise a small group of estimators. Salary high. (*d*) Design engineers or designers, heavy industrial plants, graduate mechanical or mining engineers, minimum of ten years' experience in the design of large industrial plants. Prefer applicants with a detailed knowledge of metal plants such as mills, concentrators, smelters, and refineries. This includes crushing, screening, and materials-handling experience. Salaries open. West. W-7281.

Engineers. (*a*) Contract specialist, industrial, experienced in industrial-contract negotiation and administration. Some government contract experience preferred. $9890. (*b*) Mechanical engineer, trainee, graduate, with some courses in nuclear engineering. To start, $5430. New York, N. Y. W-7282.

Vice-President, Research and Engineering, for manufacturer of fabricated industrial products suitable for foundry and machine-shop manufacture. Corporate administration of product development and research essential. Salary high. Eastern Pa. W-7293.

Engineers. (*b*) Mechanical engineer, graduate, at least five years' experience in design of industrial, process, and power-plant layout and piping. (*c*) Piping draftsmen experienced in design and detailing of industrial and process-piping systems. Three to five years' experience. Salaries good; fringe benefits. Apply by letter giving complete resume of education and experience with salary requirements. Ala. W-7296.

Mechanical Engineer Designer, graduate, at least five years' automatic and special machinery experience in knitting or allied fields. Knowledge of control mechanisms and safety devices desirable. $7500 minimum. Pa. W-7300.

Executive Vice-President for a fully integrated, independent oil company, experienced in either oil exploration or production. Administrative record, personality, and drive should be such that he can immediately begin learning responsibilities of presidency of the company. $25,000-$50,000, plus other incentives. Southwest. W-7302.

Packaging Engineer, to do planning of packaging-machinery installations, prepare specifications for machinery, follow-up preparation of construction drawings and specifications for contractors use in bidding and installing the machinery and related conveyers, sheet-metal work, and utility services. Must be qualified to carry a packaging project from beginning through to the production objective. About $10,000. Mich. W-7303.

Teaching Position available in mechanical engineering in the machine design and dynamics of machines area. Salary and rank dependent upon education and experience. East. W-7305.

Consulting Engineers for temporary survey assignment on planning, plant layout, tooling, in connection with the following: (*a*) Heavy duty forgings with swaging for the production of forgings for the manufacture of gears, axles, etc. R.R. axles. (*b*) Fabrication of automobile chassis, frames, stampings for automobiles, farm tractors, buses, and trucks, etc. (*c*) Fabrication of swaging parts, all types of parts, for automobiles, farm tractors, trucks, etc. (*d*) Designing and the manufacture of diesel and gasoline engines. (*e*) Working out and laying out, developing, etc. of factory planning, plant layout, tool engineering, analysis, methods, and time study, etc. (*f*) Design and manufacture of gears, gear boxes, transmissions, etc. Will accept retired engineers. Salary high. Mexico. F-7311.

Factory Planning Manager, degree in mechanical or industrial engineering, at least ten years' experience in heavy industry. Will supervise preparation of all factory layouts; guide the design and necessary follow-up to insure economical packaging, crating, and skidding of a variety of products. To $13,000. Upstate N. Y. W-7312.

Design Engineers, graduate mechanical or chemical, minimum of three years' experience of thermal design of heat exchangers, surface condensers, etc. Salary and assignment commensurate with experience. Eastern Pa. W-7315.

Industrial Engineer, graduate mechanical or industrial, two to three years' experience, for time and motion-study installation in foundry, machine shop, and buffing plant. Excellent opportunity. Salary open. Va. W-7316.

Sales Manager, BSME preferred; five years' engineering and sales experience in similar type of company. Knowledge of practical die design, job-shop stamping operations, including eyelet-machine products. Duties will involve managing of a Southern Calif. precision metal-stamping company, specializing in deep drawn products. Some travel; no car required. $12,000-$15,000. Employer will pay fee. Southern Calif. C-7382.

Piping Design Specialist, project level; ten years' experience plant layout, equipment process piping design. Know flow materials, pressure drop calculations, and cost estimation. Will head up a central group of piping engineers. To $9500 Employer will pay placement fee. Minn. C-7388 (*a*).

Sales Engineer, Air and Hydraulic Controls, sales background in mechanical equipment to users, jobbers in cement industrial trade; familiar with pneumatc and hydraulic control and actuators desirable (valves, pumps, motors, compressors) as applied to machinery or equipment. Opportunity for indoctrination in engineering, sales, and production departments and sales engineering help in field. Salary and commission, about $10,000. Southern Calif. S-4195-R.

Plant Engineer, Clay Products, preferably graduate mechanical, knowledge of materials-handling equipment and machine-shop operations, to work with plant superintendent and shop foreman on mechanical problems. Some board work on mold designs and conveyers. $7200. Contra Costa County, Calif. S-4203.

Mechanical Design Engineer, Machinery, preferably graduate, several years' experience as draftsman and designer of conveyers, special machinery, and equipment for process industries. Must know gears, welding, machinery, and erecting methods. Position with a manufacturer. $7800, and up. San Francisco, Calif. S-4205.

Sales Engineer, Process Machinery, BS, good sales record; preferably acquainted with users of food-processing or raw material-handling machinery; 25 per cent travel for a manufacturer. Salary open, with incentive, to $24,00. West Coast. S-4206.

Sales Engineer, Machinery, graduate mechanical, chemical, or mining, experience selling machinery for mining and construction industries—crushers, mills, conveyers, pumps, shovels, explosives, etc. Must have administrative ability; some foreign experience desirable. U. S. citizen. Single or married with young children. Three-year contract; $7800-8400 a-year base, plus 75 per cent for living allowance in pesos. Philippine Islands. S-4207.

Technical Director, PhD in basic sciences, for large corporation manufacturing diversified commercial and military products. Must have record of creative development, broad perspectives, and thoroughly practical engineering approach toward problems involved in marketing new products. About 50 per cent travel time. $20,000-$25,000, plus bonus. Los Angeles area. S-4208.

Mechanical Designers, Process Machinery, mechanical graduates, four to five years' experience on design of process machinery and /or equipment, pressure vessels, heat exchangers, pumps, etc. Should know welding techniques. Security clearance. $7200-$8400. Interview expense paid by employer. Northwest. S-4213.

Chief Mechanical Engineer, Hydropower, graduate mechanical, ten to 15 years' experience, preferably all related to hydroelectric power plants and able to design, inspect, and test turbines, governors, pen-stock welding, etc., under direction of project engineer. Large hydroplant construction job. Two-year contract. Housing available. U.S. citizen. Salary open. Pakistan. S-4214.

Designers, Engineers, Machinery, mechanical graduates or equivalent, experienced in engineering services-type work (engineering, design, layout or drafting) on machine tools, food-processing machinery, automotive manufacturing machinery; all levels from board work to supervisory are needed. Salaries at going levels, commensurate with experience. San Francisco East Bay. S-4224.

Designers, Engineers, Power, Pipe, mechanical graduates or equivalent, experienced in engineering services-type work (engineering, design, layout, or drafting) on steam-power or process-plant heavy piping (particularly interested in nuclear power experience) all levels from board work to supervisory are needed. Salaries at going levels, commensurate with experience. San Francisco East Bay. S-4225.

Designers, Mechanical Construction, graduate mechanical, well experienced in constructing-engineers-type of work on heavy project, cement plants, grain plants, storage, and construction other than commercial or light industrial. Should be able to handle mechanical projects from the ground up, including machinery, materials-handling equipment, and mechanical services. Able to work in medium-size office on a complete project from planning through completed board work, some field work and expediting. Long-established engineering construction firm. $7200-$8400, and up. San Francisco. S-4243.

Engineers. (*a*) Project engineer, electronics, graduate electrical, to direct-custom-engineering group in design of modifications of standard data-handling equipment to meet customer requirements. Capable of dealing directly with customers and providing liaison with manufacturer. Familiar with digital and logic circuitry. (*b*) Project Engineer, Electronics, graduate mechanical, to direct high-precision reader project. Should have experience with intricate mechanisms, precision-measuring techniques, and optics. $10,800-$13,200. Southern Calif. S-4260.

Administrative Engineer, Electronics, minimum of two to four years' experience in supervising, at least two years' training in administrative subjects, or experience equipment. In charge of engineering services including drafting, records and standards, model shops. Engineering degree not essential, but must be familiar with engineering groups. Responsible for engineering department budgets, manpower forecasting and control, etc. $9600-$12,000. Southern Calif. S-4261.

Assistant Plant Engineers, Heavy Chemicals, 2; one, graduate electrical, one junior mechanical; one to five years' experience in general plant-engineering-type work related to chemical-process plants (phosphates, catalysts, magnesium, ethyl defoaming). Electrical assistant should know lighting, power, and general electrical problems encountered in maintaining or modifying existing plant, installations of new equipment, and machinery and expansions to plant. Mechanical man should know piping, pumps, receivers, and material-handling equipment in chemical plants. Both must be able to do work encountered in engineering department, plant, and process departments and perform such board work as necessary. Positions with multiple manufacturer. $5700-$7800, depending upon experience. San Francisco East Bay. S-4268.

Assistant Plant Engineer, Heavy Chemicals, mechanical, chemical, or mining graduate, well qualified to assist plant engineer and assistant manager in maintaining, modifying, and expanding a going chemical plant, should be qualified in chemical process relating to corrosive acids, piping, pumping, and controlling manufacturing processes in a plant of 40 to 50, with 10 or 12 staff people. Past experience should include chemical-process work on mineral extractions work—grinding, pulverizing, and thickening equipment. $6000-$7200. San Francisco East Bay. S-4270.

Take-Off Engineer, Highway Construction, construction background, well experienced in taking off, making extensions and price materials and quantities (concrete, steel, earthmoving, road building, and servicing); should know how to handle and figure quantities accurately, make extensions, and be familiar with standard prices and cost. Position with general highway contractor. $7800. San Francisco. S-4272.

Designer, Steel Mills, graduate, minimum of 15 years' complete steel-plant design including at least three years actual work in steel-plant operations; record of several years at top project engineering level (hub-of-wheel-job with management, client, engineering, and design departments); must now be working on design and layout of installations including blast open hearth, oxygen lance (LD), and all maintenance equipment and appurtenances in complete steel plant; including equipment layout and building arrangement. Able to operate at high decision-making level. For engineering and building firm. Relocation and placement fees paid by employer. Apply by letter, in confidence. $15,000 a-year level. S-4277.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

The application of each of the candidates listed below is to be voted on after May 25, 1959, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

Alabama

Bedenbaugh, John P., Decatur
Jervis, Ogden W., Mobile
Yates, Iva C., Jr., Mobile

California

Bear, David L., Los Angeles
Clark, Kenneth M., Riverside
●Christman, Paul E., Los Angeles
Crellin, John L., San Mateo
Crino, Arthur D., Whittier
●Frisch, Joseph, Berkeley
Gale, Earl G., Jr., Oxnard
Kimball, Howard M., Jr., Corona Del Mar
Laskey, Richard R., Los Angeles
Mott-Smith, Stanley, Palo Alto
Noyes, Richard C., Van Nuys
Pingle, Ralph F., Sunnyvale
Potter, Robert B., Los Angeles
Price, Derek J., Arroyo Grande
Selbe, Allen F., San Francisco
Takahashi, Yasundo, Berkeley
Virco, John F., Arlington
Weiss, William A., Los Angeles
Winders, Marvin S., Garden Grove

Connecticut

Dahn, Raymond C., Jr., Trumbell
Gannon, John M., Noroton Heights
Goldbach, Richard A., New London

Delaware

Armstrong, Robert J., Wilmington
Godshall, William H., Dover
●Olson, Gordon A., Seaford
Turner, John R., Wilmington

District of Columbia

Abouchar, John W., Washington
Pick, George, Washington

Florida

Farnell, Jimmie E., Pensacola
Verna, Bernard J., Pensacola
Worden, Edson A., Eglin AFB

Georgia

Finch, Charles H., Atlanta
●Rogers, Harry C., Augusta

Illinois

Anderson, Marvin E., Lansing
●Birmingham, William J., Chicago
Casey, John A., Chicago
Fishe, Gerald R. A., Carbondale
Hassan, Mohammad Z. U., Chicago
Klokkenga, Donald A., Delavan

●Transfer to Member or Affiliate.

●McClain, Arthur W., Woodstock
Schaffer, Paul R., Chicago
Wagner, Richard C., Berwyn
Wu, Shi T., Chicago

Indiana

Kessler, Richard, Highland
●Mustafa, Marvin, Whiting
Pickard, William E., Indianapolis
Seethaler, Robert A., East Chicago

Kentucky

Gowan, John W., Paducah

Louisiana

Clark, Thomas D., Jr., Lafayette
Cox, Donald E., Shreveport
Heitkamp, Roy S., New Orleans
Hughes, William J., Baton Rouge
Mooney, Joseph R., New Orleans
Stevens, Paul N., New Orleans

Maine

Zollo, John P., Rumford

Maryland

Bayliss, Orrie B., Jr., Hyattsville
●Fieser, George W., Adelphi
Hobbins, Joseph N., College Park
Kimbrough, Laurence B., Baltimore
Peach, James W., Baltimore

Michigan

Cioth, Boguslaw B., Kalamazoo
●Daniels, Roger L., Oak Park
Haddad, Mitchell J., Detroit
Pakvis, Adrian, Royal Oak
West, Fred, Detroit
●Whiddon, Oslin D., Grosse Pointe Woods

Massachusetts

Bloss, Ernest K., Boston
Driscoll, William G., Jr., Framingham
Huse, Arthur E., Springfield
Larsen, Allan R., Wakefield
Moore, Herbert C., Boston
Parker, Franklin P., Boston
Schiffer, Peter, Cambridge
Staniszewski, Bogumil E., Cambridge
●Sundberg, Henry L., Jr., Longmeadow
Wetherby, Robert E., Lynnfield Center
Zilly, Robert G., Boston

Minnesota

Katterheinrich, Fred H., Minneapolis
Raley, Frank A., Minneapolis

Mississippi

Brunson, Fred W., St. Louis

Missouri

Allen, Alvin C., Independence
Billings, George J., Jr., Florissant
Ostroot, George, Jr., St. Louis
Stiller, Milton A., Kirkwood
Teri, Henry F., Kansas City
Yaeger, Ralph A., Rock Hill

Nebraska

Oswald, Ronald E., Lincoln

New Jersey

Carrie, James P., Newark
Kidder, Richard H., Haddonfield
●Merker, George, Maywood
Vecchiotti, Frank, Little Ferry
●Zoschak, Robert J., Rutherford

New York

Bosch, Frederick W., Bataria
●Burns, William J., Hicksville
Clarke, James A., Plainview
Cooper, Kenneth K., Utica
Dropkin, David, Ithaca
●Eis, Ralph O., Schenectady
Fitzgibbons, William, Jr., Hicksville
Goon, William, New York
Groves, James A., Wellsville
Hofmann, Charles S., Pattersonville
Johansson, Eric B., Schenectady
King, Raymond P., Rochester
Koch, Paul A., Bronx
Krieg, Reuben, Brooklyn
Landes, Ralph, Brooklyn
Law, Charles W., Owego
Meylan, Jules A., White Plains
Otto, Josquin E. G. C., New York
Pergola, Angelo C., Little Neck
Perl, Alexander I., Flushing
●Petruzzi, Claude E., Bronxville
●Phillips, Henry, New York
Pierce, Ross M., Amsterdam
Runken, Gerd, Cold Spring on Hudson
●Schlessinger, Monroe, Tonawanda
Shanker, Suryanarayana S., New York
Siegel, Joseph, New York
Sigda, Joseph R., New York
Slotkin, Martin, Brooklyn
Steginsky, Paul M., Plainview

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME FIRST NAME MIDDLE NAME

POSITION TITLE NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) Division, if any

*☐
EMPLOYER'S ADDRESS City Zone State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐
HOME ADDRESS City Zone State

☐
PRIOR HOME ADDRESS City Zone State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

Address changes effective when received prior to:

☐ Mechanical Engineering — 10th of preceding month
☐ *Journal of Engineering for Power*
☐ *Journal of Engineering for Industry*
☐ *Journal of Heat Transfer*
☐ *Journal of Basic Engineering*
☐ *Journal of Applied Mechanics* — 20th of preceding month
☐ *Applied Mechanics Reviews* — 1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation
☐ B—Applied Mechanics
☐ C—Management
☐ D—Materials Handling
☐ E—Oil and Gas Power
☐ F—Fuels
☐ G—Safety
☐ H—Hydraulics
☐ I—Human Factors Group
☐ J—Metals Engineering
☐ K—Heat Transfer
☐ L—Process Industries
☐ M—Production Engineering
☐ N—Machine Design
☐ O—Lubrication
☐ P—Petroleum
☐ Q—Nuclear Engineering
☐ R—Railroad
☐ S—Power
☐ T—Textile
☐ U—Maintenance and Plant Engineering
☐ V—Gas Turbine Power
☐ W—Wood Industries
☐ Y—Rubber and Plastics
☐ Z—Instruments and Regulators

Stenard, Robert K., Garden City
Tzeng, Sheng-Tung, Wellsville
Wolowodiuk, Walter, Flushing
●Yu, Aiting T., White Plains

Ohio

●Ast, Herman J., Bedford
Brittenham, Edward A., Jr., Akron
Brown, Donald R., Dayton
Bryant, Gordon B., Cuyahoga Falls
Burel, William J., Cincinnati
DeBoe, Homer M., Toledo
Kropp, Donald E., Elyria
Larson, Robert B., Cleveland
Lepp, Gerhard J., Cuyahoga Falls
Ludwig, Carl, Cleveland
●Marco, Salvatore M., Columbus
Mentzer, Edward W., Alliance
●Niedenfuhr, Francis W., Columbus
Sibley, Lewis B., Columbus
●Starkey, Walter L., Columbus
●Purdy, James B., Columbus
Veney, Marlin V., Cincinnati
Volk, Joseph F., Jr., Brecksville

Oklahoma

●Kleinmann, Earl E., Bartlesville
Pederson, Oscar E., Tulsa

Pennsylvania

Chatterjee, Gour L., Bethlehem
Cobonpue, John O., Pittsburgh
●Eldon, William A. C., Drexel Hill
●Fadden, William J., Jr., Ridley Park
Fayer, Ervin, Philadelphia
Flett, David, Pittsburgh
Getsko, Joseph, Jr., Pittsburgh
●Hamm, Paul J., Abington
Kalyanasundaram, Viswanathan, Pittsburgh
Kane, John J., Pittsburgh
Larsen, Peter J., Erie
Lewis, Allen R., Easton
Mastro, Armand J., Philadelphia
Matayas, Robert M., Pittsburgh
McLaughlin, R. Wayne, Jeannette
Mills, Charles W., East Pittsburgh
Mondal, Bhim C., Pittsburgh
O'Connor, James M., Philadelphia
Olson, Vernon A., Glenside
Ptacek, Frank, Glenside
Quigley, James L., Erie
Rhodes, Milton C., Jeannette
Schmid, Walter, Philadelphia
Schnitzer, Tadeusz E., Pittsburgh
Weber, Edward H., 3rd, Pittsburgh
Weller, Ray E., Erie

Rhode Island

Shepard, Gordon E., Jr., Warwick

South Carolina

Buckley, Charles E., Aiken
Howell, Herbert C., Greenville
Quinn, Lawrence F., Camden

Tennessee

Cunningham, Ralph J., Chattanooga
Volk, Eugene R., Chattanooga

Texas

●Crump, Jack S., Corpus Christi
Davis, Joe C., Channelview
Delgado, Jose E., Corpus Christi
Goodman, Fred K., Houston
●Hall, George D., Houston
Jobe, Russell G., Pasadena
Johnson, Thomas M., Jr., Freeport
Krizak, Eugene J., Baytown
Landers, Wilson H., Bishop
Merritt, John C., Houston
Perry, John V., Jr., College Station
●Rochelle, William R., Houston
Saunders, John W., Baytown
Smith, Henry D., Houston
●Tagg, Jerome, Houston
Walker, Ralph F., Jr., Houston
Warrington, Francis D., Dallas
Willbern, Arthur D., Jr., Bishop

Utah

Hayes, Robert D., Provo

Virginia

Bartell, Russell J., Arlington

Washington

Wells, Glen W., Richland

West Virginia

Barna, John W., St. Albans

Wisconsin

Jorgensen, Arthur J., Wauwatosa
Powis, Russell W., Beloit
●Slater, John G., Milwaukee

Foreign

Campos De Moraes, Paulo A., Fortaleza, Ceara, Brazil
Doraiswamu, Lakshmipuram, Rayonpuram, Kerala State, South India
Gonzalez-Vallejo, David, Durango, Dgo Mexico
Huber, Robert, Bellevue (S.&O.), France
Lane, Derek, Toronto, Ont., Canada
Mitter, Kiron A., West Bengal, India
Orr, William A., St. Catharines, Ont., Canada
Paterson, Bryant, Colombo, Ceylon
Rosenzweig, Humberto L., Sewell, Chile
●Skolnick, Edward, Downsview, Ont., Canada

W. H. McBryde, 59th ASME President, 1876–1959

Warren Horton McBryde, past-president and Fellow ASME, consulting engineer, industrialist, world traveler, and yachtsman, died March 25, 1959. For most, achievement in any one of these fields suffices to fill a lifetime. For Warren McBryde, the lifetime was punctuated by a series of achievements in service to his profession, to industry, and to his community.

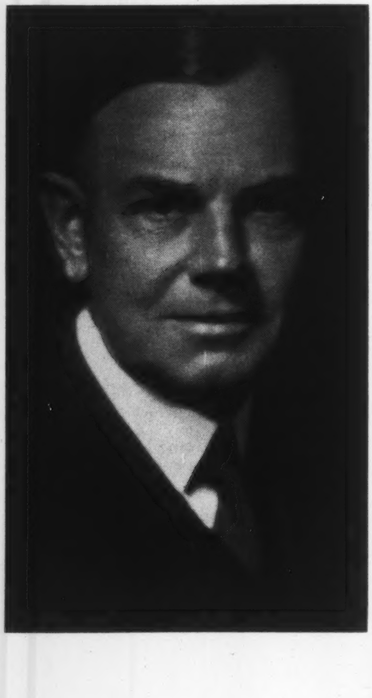
Mr. McBryde was elected a member of ASME in 1921, in 1942 he was made a Fellow. He was chairman of the San Francisco Section 1925–1926. In company with Calvin W. Rice, late Secretary of ASME, he represented the Society at the 75th Anniversary of the Verein deutscher Ingenieure at Cologne, Germany, 1931; he also attended the 1931 and 1935 spring meetings in England of The Institution of Mechanical Engineers. In 1937 Mr. McBryde was elected a vice-president of the Society, and as such took great interest in the activities of ASME Student Members attending meetings at universities on the West Coast as well as Student Group Meetings. His service to ASME was culminated in 1939–1940 when he served as President. His nine years of service as a member of the Council of ASME ended in 1945.

He was born at Mobile, Ala., in 1876, the son of Thomas Calvin and Julia P. (Horton) McBryde. He studied at the Alabama Polytechnic Institute at Auburn, majoring in electrical and mechanical engineering. He was graduated in 1897 with a BS degree. In 1948 an honorary LLD degree was conferred upon him by the University of Santa Clara.

The engineering career which distinguished him, began immediately after graduation from Alabama Polytechnic Institute when he joined the Electric Lighting Company of Mobile, Ala. Later he did architectural drafting and designing for George F. Barber & Company, Knoxville, Tenn.

From 1899 to 1903, Mr. McBryde was employed by the Yuba Electric Power Company as assistant resident engineer in charge of construction on the Colgate hydroelectric powerhouse, in northern California; by the Peyton Chemical Company, San Francisco and Martinez, Calif., as assistant superintendent of design and construction; and by the Bay Counties Gas & Electric Company, as chief draftsman and assistant to the chief electrical and mechanical engineer. In 1903 he joined the Engineering Department of the E. I. du Pont de Nemours & Co., Inc., upon its formation and was its first resident engineer in charge of construction at its Rapauno Plant, Gibbstown, N. J., from 1903 to 1905, building large sulfuric and nitric acid plants and an experimental nitroglycerine plant. In 1905 he was transferred to Hercules, Calif., to construct a large sulfuric acid plant. In 1906 he was appointed the first chief of the West Coast Engineering and Construction Department of the du Pont organization. Subsequently he became assistant superintendent of its Hercules plant until its establishment as the Hercules Powder Company in 1912, remaining at his post until 1919. At that time he became secretary of the California and Hawaiian Sugar Refining Company, San Francisco, and assistant to the general manager, handling many important engineering problems for the company until 1927 when he entered his own consulting practice.

Warren Horton McBryde



In time of war, Mr. McBryde was ready to serve his country. His lifetime spanned three wars, and he served in each. During the Spanish-American War, he served in the U. S. Lighthouse Department and the U. S. Corps of Engineers at Fort Morgan, Ala., and had charge of the submarine mines, searchlights, and electrical equipment guarding the entrance to Mobile Bay. Following this, he was made the chief electrician of the U. S. Army Transport *Sheridan*, on which he made a voyage from New York, via the Suez Canal, to the Philippines, stopping at Gibraltar, Malta, Ceylon, Singapore, Nagasake, Japan, and San Francisco.

In World War I, he was in charge of all maintenance and repairs and handled many important engineering problems in connection with the hurried construction of 12 large TNT plants, the necessary nitro-and-sulfuric-acid plants, and many other industrial buildings. He was also in charge of the labor and industrial relations department of the company (Hercules) and secured positions for more than three quarters of the 4000 men under his supervision when demobilization came.

In February, 1941, Mr. McBryde was called to Washington, D. C., to be Chief of the Mechanical Engineering Unit, to redesign, where necessary, all of the mechanical equipment of the camps of the U. S. Army's construction program and projects. In April, 1941, in addition to the afore-mentioned, Mr. McBryde was appointed Chief of (Munitions) Plant Unit, to supervise the preparation and approval of the detailed plans and working drawings and to standardize the designs of the Ordnance and Chemical Warfare Service projects of the U. S. Army. On Aug. 1, 1941, Mr. McBryde was promoted to Chief Consulting Mechanical Engineer and Chief Consultant (Munitions) Plants. In 1942 he was made Chief of the Marine Design Section of the Transportation Corps of the U. S. Army to design all of the boats up to 1000 tons and was made Chief of the Engineering Division upon its formation. This also included the preparation of plans and specifications for all of the Army's railroad lend-lease equipment. His work completed, in 1944, he resigned this post. He was then retained as consultant by the Transportation Corps of the U. S. Army, also by the Army-Navy Explosives Safety Board, and in an advisory capacity by the Research Department of the Industrial College of the Armed Forces—also resuming his practice as consulting engineer.

As a world traveler, Mr. McBryde circumnavigated the globe three times. These trips gave him an opportunity to visit and to study some 80 countries, and at least 250 of the world's ports. He observed the engineering progress and industrial developments, harbor improvements, port facilities, transportation systems, and industrial, mineral, and agricultural products of these countries. At the same time he familiarized himself with their domestic commerce and foreign trade, their economic conditions, and their political problems as well.

As an enthusiastic yachtsman, Mr. McBryde was one of three judges of the 1932 Olympic Games yacht races in Los Angeles. A friend of Sir Thomas Lipton, he sailed with him on the *Shamrock* in races at Cowes in August, 1929, and once against the King of England on the *Britannica* in a race held off the Isle of Wight. At the time of his death, he was putting the final touches on plans to serve for the twentieth time as judge of the course for the Hearst All-Clubs Regatta.

Mr. McBryde had been active in civic affairs serving as a member of numerous boards and councils. He had at one time been Mayor of Hercules, Contra Costa County, Calif. He was a member also of The Newcomen Society and Tau Beta Pi.

He is survived by two daughters, Lucille McBryde and Mrs. Janet Orser. His wife, the former Abbie Ford White, died a year and a half ago.

OBITUARIES

George Frederic Albrecht (1880–1958), owner, Albrecht Manufacturing Co., Saco, Maine, died in 1958. Born, Boston, Mass., Oct. 27, 1880. Education, schools of Salem, Boston, and Newton Mass. Mem. ASME, 1931. Mr. Albrecht was a specialist in the field of textile machinery, tools, and fixtures.

Thomas Hampton Allen (1881–1958), president, Memphis Light, Gas, and Water Division, City of Memphis, Memphis, Tenn., died Dec. 27, 1958. Born, St. Louis, Mo., Oct. 27, 1881. Parents, Richard H. and Lizzie Allen. Education, BS(ME), University of Tennessee, 1903; hon. DS, Southwestern University, 1950. Married Phyllis Blanchard, 1909. Mem. ASME, 1912. Mr. Allen had been president and chief engineer of the Memphis utility since 1940. During World War I he had been a major in the U. S. Army Corps of Engineers. He had been a trustee of the University of Tennessee; vice-mayor, and Commissioner of Fire and Police, City of Memphis; Commissioner of Streets, Bridges, and Sewers, City of Memphis; member, Board of Architectural and Engineering Examiners and Board of Water Commissioners; chairman, Board of Light and Water Commissioners. Mr. Allen was a registered professional engineer in the States of Tenn., Ark., and Miss.

Thomas Leighton Blyth, Jr. (1927–1958), mechanical engineer, New York Div., The Austin Co., Roselle, N. J., died May, 1958. Born, Peoria, Ill., Aug. 27, 1927. Education, BS, Florida Southern College, 1950; BS(ME), Rensselaer Polytechnic Institute, 1952. Assoc. Mem. ASME, 1952.

Albert Kenneth Brown (1895–1958), Riggs Distler & Co., Inc., Philadelphia, Pa., died Nov. 23, 1958. Born, St. Louis, Mo., June 27, 1895. Parents, Walter S. and Ella (Romanowski) Brown. Education, St. Louis Manual Training School, Lehigh University. Assoc. Mem. ASME, 1921; Affiliate ASME, 1925; Mem. ASME, 1935. During World War I, Mr. Brown served as an engineer officer. Member also Society of American Military Engineers.

Samuel Northrup Castle (1880–1959), industrialist, consulting engineer, business executive, and inventor, Honolulu, Hawaii, died Feb. 10, 1959. Born, Honolulu, Hawaii, Feb. 6, 1880. Education, Halle a/d Salle, Germany; Hamilton College; AB, Harvard College, 1901; graduate study, Cornell University. Married Anna Ellison Haviland, 1903. Assoc. Mem. ASME, 1909; Mem. ASME, 1911. Mr. Castle had been a member of the board of directors of The Advertiser Publishing Co.; secretary and vice-president, Honolulu Rapid Transit Co.; and a vice-president of Castle & Cooke; and had been a director and vice-president of Ewa Plantation Co., Kohala Sugar Co., Waialua Agricultural Co., and Helemana Co. He had served as a member of the maritime affairs committee of the Honolulu Chamber of Commerce, and had been a member of the board of the Hawaiian Pineapple Co. Mr. Castle's early engineering experience was gained with such U. S. firms as Westinghouse, Allis-Chalmers, and General Electric. During World War I he helped devise formulas for large-scale production of special hard steels used in the manufacture of munitions and armaments. He was a lecturer at the U. S. Army Artillery School at Sandy Hook, N. Y. He returned to Hawaii in 1930. Among his inventions were a centrifugal gas oiling device for Corliss engines and a type of fog-piercing searchlight. He was the author of many technical papers and engineering articles. Mr. Castle, in 1955, received the ASME 75th anniversary medal. He had been active in founding, in 1953, the ASME Hawaii Section. He was a member also of AIME, AIChE, SAE, and had been a member of SAME, AOA, and the Newcomen Society. Survived by a son, Northrup Haviland Castle; three grandchildren, and five great-grandchildren.

Robert Telford Couch (1892–1958), manager, gasoline Dept., United Fuel Gas Co., Charleston, W.Va., died Sept. 25, 1958. Born, Charleston, W. Va., Sept. 27, 1892. Education, high-school graduate. Mem. ASME, 1952. Mr. Couch had been with United Fuel Gas since 1949, and prior to that time had been with Virginian Gasoline & Oil since 1927. Survived by his widow.

Edwin Terry Day (1896–1958), Captain (Ret.), Bureau of Ships, U. S. Navy Dept., Sayleville, R. I., died July 20, 1958. Born, Providence, R. I., Feb. 10, 1896. Parents, Edward Brainard and Mada Terry Day. Education, Webb Institute of Naval Architecture, 1920. Married Elizabeth Sutherland, 1921; three daughters, Elizabeth, Anne, and Helen. Mem. ASME, 1931. Capt. Day had been a specialist in boiler and power-plant design, construction, and operation.

Alfred William Doll (1903–1957), whose death in December, 1957, has recently been brought to the attention of the Society had been acting dean of the School of Engineering, Pratt Institute, Brooklyn, N. Y. Born, Philadelphia, Pa., June 5, 1903. Parents, Valentine and Katherine Doll. Education, BS(ME), University of Pennsylvania, 1924; ME, 1931; MA, Columbia University, 1928; PhD, New York University, 1932. Married Helen A. Nicholson, 1932; two daughters, Katherine R. and Susan Jo. Mem. ASME, 1938. Dr. Doll who had been on the faculty at Pratt since 1925, had been named acting dean in 1953. He was coauthor of a series of texts used by students at Pratt in courses of physics. Member Sigma Xi and Tau Beta Pi.

John E. Dutcher (1873–1955), engineer, Schmidt, Garden & Erikson, Chicago, Ill., died in 1955. Born, Iowa City, Iowa, Jan. 11, 1873. Education, BS(EE), University of Wisconsin, 1897. Mr. Dutcher had been with the Chicago firm of engineers since 1907. Mem. ASME, 1922.

Arndt Francke Ericksen (1907–1957), sales engineer, Detroit Stoker Co., Chicago, Ill., died Nov. 3, 1957. Born, Chicago, Ill., Oct. 18, 1907. Education, BS(Arch), Armour Institute of Technology, 1929. Mem. ASME, 1948. Mr. Ericksen had been with Detroit Stoker since 1940.

William Earle Goodere (1903–1959), new construction representative, Todd Shipyards Corp., Houston, Texas, died Jan. 31, 1959. Born, Chicago, Ill., Aug. 26, 1903. Education, attended YMCA Tech and UCLA and USC extension courses. Mem. ASME, 1948. During World War II, Mr. Goodere served as a major in the air forces procurement program. He had been commanding officer in charge of engineering, production, and material in all phases of aircraft procurement at Northrup Aircraft, Hawthorn, Calif. Member also of Society of American Military Engineers.

Fritz Paul Grutzner (1887–1959), engineer in charge of diesel-locomotive engineering, Fairbanks, Morse & Co., Beloit, Wis., died Jan. 27, 1959. Born, Strehlen, Germany, June 2, 1887. Parents, Carl and Elisabeth Grutzner. Education, Maschinenbauschule, Nürmberg, Germany, 1906. Married Gertrude L. Ehlers, 1924; children, Ruth Elizabeth and Edward Ehlers Grutzner. Naturalized U. S. citizen, Janesville, Wis., 1926. Mem. ASME, 1923. A specialist in diesel-engine power plants, Mr. Grutzner had taken out several patents assigned to firms with which he was associated. He had served the Society as chairman of the Rock River Valley Section. He was a member also of the Verein Deutscher Ingenieure.

H. Clay Henning (1884–1958), division engineer in charge of purchase of boiler pumps and mechanical equipment, St. Louis Water Div., St. Louis, Mo., died Aug. 29, 1958. Born, St. Louis, Mo., Dec. 9, 1884. Parents, Henry and Abigail (Sullivan) Henning. Education, BS(ME), Christian Brothers College, 1905. Married Louise Vonnahme, 1908; two children, Vivian Louise and Jean Victory. Mem. ASME, 1925. Mr. Henning had been with the St. Louis Water Div. since 1908. He had served the Society as a member of the executive committee of his local section in 1930.

William Lewis Hewes (1885–1958), retired assistant director of purchases, Hercules Powder Co., Wilmington, Del., died Oct. 4, 1958. Born, Beaver Valley, Delaware County, Pa., Feb. 3, 1885. Son of James H. Hewes. Education, Drexel Institute and Goldey College. Married Annetta Phillips, 1914. Affiliate ASME, 1957. Mr. Hewes had been with the Hercules Powder Co. since 1914. He is survived by his widow; and four children, Mrs. Herbert R. Tonnell, Jr., William L. Hewes, Jr., Mrs. Alfred H. Bent, and Mrs. F. Harvey Escott.

Reginald William Hewitt (1899–1958), director, Fabrication Division, Automatique Electrique & A., Edeghem-Anvers, Belgium, died Nov. 13, 1958. Born, Coventry, England, Dec. 29,1899. Education, BS, Birmingham University, 1923. Assoc. Mem. ASME, 1927. Before joining the Belgian firm in 1945, Mr. Hewitt had been with the telephone manufacturers of India, Ltd.

Gustav Hirsch (1876–1958?), whose death recently was reported to the Society had been consulting engineer and president, Gustav Hirsch Organization, Inc., Columbus, Ohio. Born, Columbus, Ohio, Nov. 4, 1876. Parents, Leonhard and Charlotta Hirsch. Education, ME(EE), Ohio State University, 1897. Married Aletta Kremer; one daughter, Irene Hirsch. Mem. ASME, 1913. Mr. Hirsch had been engaged in consulting engineering since 1902. He had served during the Spanish-American War as a lieutenant in the Signal Corps, and in World War I advanced to the rank of lieutenant colonel. Mr. Hirsch was a registered professional engineer in the State of Ohio. He was a member also of AIEE and AAAS.

Walter Edwin Hopton (1865–1958), retired, formerly principal partner, The Hopton Co., Syracuse, N. Y., died Oct. 20, 1958. Born, Bridgeport, Conn., June 11, 1865. Education, SB, Massachusetts Institute of Technology, 1891. Assoc. Mem. ASME, 1891; Mem. ASME, 1896.

Henry Kanniainen (1906–1958), senior design engineer, Union Carbide Chemicals Co., Div. Union Carbide Corp., South Charleston, W. Va., died June 23, 1958. Born, Hardwood, Minn., Dec. 13, 1906. Education, BS(ME), University of Minnesota, 1932. Mem. ASME, 1949. Mr. Kanniainen was a specialist in air-conditioning and steam-power and chemical-plant mechanical design. He was a registered professional engineer in the State of West Virginia. Member Pi Tau Sigma. Survived by his widow who resides in St. Albans, W. Va.

William Karl (1930–1955), U. S. Navy, BOQ, Naval Air Station, Pensacola, Fla., was killed in a jet crash March 7, 1955. Born, Brooklyn, N. Y., Feb. 3, 1930. Education, BA, Columbia College, 1952; BS(ME), Columbia School of Engineering, 1953. Assoc. Mem. ASME, 1953.

Iven Carl Kincheloe, Jr., (1928–1958), captain, U. S. Air Force, Edwards AFB, Oakland, Calif., was killed in July, 1958. Born, Detroit, Mich., July 2, 1928. Education, BS(AE), Purdue University, 1949. Active in space-research flight testing, Capt. Kincheloe, in 1956, held the world's altitude record for manned aircraft, 126,200 ft. This record was made in a Bell X-2 rocket plane. During the Korean War, he was one of the nation's jet aces. He is survived by his wife and a son. Assoc. Mem. ASME, 1949.

John Mahon Kittredge (1909–1959), project engineer, Continental Aviation and Engineering Corp., Detroit, Mich., died Jan. 11, 1959. Born, Cripple Creek, Colo., June 24, 1909. Education, BS(ME), University of Arizona, 1934. Assoc. Mem. ASME, 1935.

Earl Collinsworth Maund (1918–1958), vice-president and general manager, Union Iron Works of California, Inc., San Francisco, Calif., died Oct. 19, 1958. Born, Birmingham, Ala., Feb. 18, 1918. Education, PE, Colorado School of Mines, 1938. Mem. ASME, 1953. Mr. Maund had been with Union Iron Works since 1950.

Frank Maytham (1903–1959), chief engineer, Link-Belt Co., San Francisco, Calif., died January, 1959. Born, Buffalo, N. Y., Dec. 10, 1903. Education, BA(ME), Stanford University, 1927. Mem. ASME, 1952. Mr. Maytham, a specialist in the design of materials-handling machinery, was a registered engineer in the State of California. He had been with Link-Belt since 1927.

Robert Anderson Miller (1889–1958?), retired, technical sales engineer, Pittsburgh Plate Glass Co., Pittsburgh, Pa., died recently according to a report received by the Society. Born, Canton, Ohio, July 20, 1889. Education, Massachusetts Institute of Technology, 1914–1916. Mem. ASME, 1931. Mr. Miller had been with PPG since 1921. During World War I, he served as a lieutenant in the U. S. Army Infantry.

Benjamin Stuart Murphy (1883–1959?), whose death recently was made known to the Society, had been vice-president, Management Counselor, Inc., New York, N. Y. Born, Jersey City, N. J., Aug. 7, 1883. Parents, Benjamin and Belle S. (Gilmore) Murphy. Education, ME, Stevens Institute of Technology, 1903. Married Sarah Christine O'Reily, 1937. Assoc. Mem. ASME, 1905; Mem ASME, 1916. Mr. Murphy had been a registered professional engineer in the States of New Jersey and New York.

Ronald Lawsone Paterson (1885–1958), senior contracting engineer, Consolidated Western Steel Div., U. S. Steel Corp., Los Angeles, Calif., died Feb. 25, 1958. Born, Omaha, Neb., April 12, 1885. Education, PhB, Yale University, 1906; attended University of Southern California and California Institute of Technology. Mem. ASME, 1948. Mr. Paterson's early career was in the area of oil-field development, design and construction of equipment. During World War II, he served as U. S. Naval Engineer and engaged in production of the 5-in. antiaircraft twin-gun mount for the Naval Ordnance Div. of Consolidated Steel Corp. He remained with Consolidated Western until his death. Member also of the Society of American Military Engineers.

Robert Peyinghaus (1891–1959), drainage engineer, Peterson and Associates, Inc., engineering consultants, Clearwater, Fla., died Jan. 19, 1959. Born, St. Louis, Mo., Sept. 19, 1891. Parents, Frank Burbbage and Daisie Mae (Dubuque) Peyinghaus. Education, attended Detroit Technological Institute. Married Saddie Annis Hunt, 1913. Assoc. Mem. ASME, 1919; Mem. ASME, 1935. Survived by his widow, and three children, Richard V. Peyinghaus, Mrs. Ann Howard, and Mrs. Helen Hills.

Ellis Laurimore Phillips (1873–1959), president, E. L. Phillips & Co., and founder and past-president, Long Island Lighting Co., New York, N. Y., died Jan. 29, 1959. Born, Naples, Steuben County, N. Y., March 1, 1873. Education, ME and EE, Cornell University, 1895; hon. LLD, Ohio Wesleyan and Florida Southern University, 1942. Married Kathryn Sisson McLean, 1919. Assoc. Mem. ASME, 1901; Mem. ASME, 1926; Fellow ASME, 1951. Mr. Phillips had been president of Long Island Lighting Co. from 1912 to 1935. During his career he had been president of Empire Power Corp. and Kings County Lighting Co. He had been chairman of the board of Queens Borough Gas & Electric Co., United Gas & Electric Corp., and United Gas Engineering Co. Mr. Phillips, through the Ellis L. Phillips Foundation, had donated the electrical engineering building at Cornell University. Other of his philanthropies included a half-million-dollar contribution toward the completion of construction of the Broadway Temple, a Methodist Church; and a $100,000 contribution to the Leonard Wood Memorial for the Eradication of Leprosy. He is a member also of AIEE and the American Society of Refrigerating Engineers. Member also Tau Beta Pi. Survived by his widow; a son, Ellis L., Jr.; a daughter, Mrs. Jean Burri, Altadena, Calif.; a twin sister, and eight grandchildren.

Albert E. Rathgeb (1895–1958), senior engineer, Plainfield, N. J., died May 26, 1958. Born, Danbury, Conn., June 17, 1895. Parents, Peter and Isabell (Wilhelm) Rathgeb. Education, attended Pratt Institute and Columbia University. Married Clare Fredrick, 1928. Assoc. Mem. ASME, 1926; Mem. ASME, 1935. Survived by his widow.

Charles Porter Roberts (1896–1958?), professor, department of mechanical engineering, Robinson Laboratory, Ohio State University, Columbus, Ohio, died recently according to a notice received by the Society. Born, Cynget, Ohio, Aug. 17, 1896. Education, B(ME), Ohio State University, 1920. Assoc. Mem. ASME, 1926; Mem. ASME, 1935. Mr. Roberts had been on the Ohio State faculty since 1922.

Charles Stanley Root (1897–1958), owner, Charles S. Root Manufacturing Co., Springfield, Mass., died Aug. 4, 1958. Born, Springfield, Mass., March 15, 1897. Parents, Joseph H. and Mary Root. Education, attended technical high school. Married 2nd, Eve White, 1954. Affiliate ASME, 1945. Mr. Root held a number of patents. During his early career he developed a small automobile for the Midget Cycle Car Co., also during that time he developed accessories such as spark plugs, priming devices, tools for repairing automotive equipment, and the like. He formed the Charles S. Root Manufacturing Co., in 1934. Survived by his widow.

Paul G. Schulz (1904–1958?), whose death recently was reported to the Society had been assistant engineer of standards, The Crane Co., Chicago, Ill. Born, Chicago, Ill., March 30, 1904. Education, high-school graduate and various college courses. Mem. ASME, 1951. Mr. Schulz was a registered professional engineer in the State of Illinois. Mr. Schulz served the Society as a member of the ASME Standardization Committee and was active on numerous other standardization committees chiefly that on screw threads. He was the author of an article on the subject of screw threads. Member also of API, and the Manufacturers Standardization Society.

Clarence K. Sencebaugh (1884–1958?) whose death recently was made known to the Society, had been consulting engineer, San Diego, Calif. Born, Chicago, Ill., Aug. 20, 1884. Education, Winona and Armour Technological Institutes, 1906. Assoc. Mem. ASME, 1922; Mem. ASME, 1935. Mr. Sencebaugh had served the Society as secretary-treasurer of the San Diego Sub-Section of the Southern California Section in 1951–1952. Survived by his widow.

Ferdinand Josiah Spang (1892–1958), president, Spang and Co., Butler, Pa., died Sept. 10, 1958. Born, Butler, Pa., March 12, 1892. Education, attended high school two years. Mem. ASME, 1943. Spang and Co. are manufacturers of oil-well drilling equipment, Mr. Spang had been with the firm since 1910. He had also been the author of a number of papers on the subject of drilling equipment. Member also American Society of Metals and the American Petroleum Institute.

Oliver Edmund Spencer (1933–1959?), field engineer, New York Sales Office, Leeds & Northrup Co., died recently according to a notice received by the Society. Born, Hartford, Conn., Jan. 14, 1933. Education, BS(ME), Yale University, 1955. Assoc. Mem. ASME, 1955. Survived by his widow, Helen G. Spencer.

William Clayton Stewart (1902–1959), technical adviser, Industrial Fasteners Institute, Cleveland, Ohio, died Feb. 6, 1959. Born, Lynchburg, Va., Dec. 7, 1902. Education, BS(EE), Washington University, 1926. Mem. ASME, 1937. Mr. Stewart had been active on a number of the Society's Standardization Committees. He was a member also of the AIEE.

William Alfred Terrell (1895–1959), owner, Terrell Welding and Machinery, Roslyn Heights, L. I., N. Y., died Jan. 27, 1959. Born, Brooklyn, N. Y., April 24, 1895. Education, School of Science and Technology, Pratt Institute; Massachusetts Institute of Technology, 1915. Mem. ASME, 1935. During World War I, Mr. Terrell served in the U. S. Army Air Service. Survived by his widow.

Michael James Vodille (1904–1958?), whose death recently was reported to the Society, had been engineering supervisor, Compressor Div., Worthington Pump Corp., Buffalo, N. Y. Born, Buffalo, N. Y., Sept. 4, 1904. Education, BS(ME), Tri-State College of Engineering, 1928. Mem. ASME, 1953. Mr. Vodille had been an active member of the ASME Buffalo Section, and had been its corresponding secretary.

Charles Oliver Wellington (1886–1959), senior partner, Scovell, Wellington & Co., New York, N. Y., died Feb. 6, 1959. Born, Belmont, Mass., Oct. 1, 1886. Parents, Arthur Jeduthan and Helen Augusta (Hill) Wellington. Education, AB, Harvard College, 1907. Married Helen Cushing Underwood, 1912 (div.); married 2nd, Lucile Pierce Rohde, 1930. Affiliate ASME, 1921. Mr. Wellington was a pioneer in the field of management engineering. He was a prominent speaker on the subject and was frequently called upon to address various groups on such matters as cost accounting, corporation finance, and allied topics. Mr. Wellington was the author of a cost accounting book, "Primer on Budgeting." He was president, 1935–1937, of the Association of Consulting Management Engineers. Survived by his widow, Lucile; a son, Roger; and seven daughters, Mrs. George Parsons, Mrs. Roger Merrill Jr., Mrs. George C. Cunningham Jr., Mrs. Martin R. Haase, Mrs. Dennis Puleston, Mrs. Knute D. Lee, and Mrs. Robert W. Barron. There are also seventeen grandchildren.

Forrest Gay Wilder (1896–1959), supervising engineer, Fay, Spofford & Thorndike, Boston, Mass., died Jan. 6, 1959. Born, Revere, Mass., Feb. 26, 1896. Education, Tilton Academy, 1915. Mem. ASME, 1944. Mr. Wilder had previously been general superintendent in charge of design, operation, and maintenance of production for Boston Sand & Gravel Co. Survived by his widow, Ethel Wilder, Cranston, R. I.

Carlos A. Willis (1921–1958), chief engineer, Ciudad Madero Div., Petróleos Mexicanos, Tampico, Tamaulipas, Mexico, died July, 1958. Born, Tampico, Tamaulipas, Mexico, April 21, 1921. Education, BS(ME), Texas A & M College, 1942. Mem. ASME, 1951. Mr. Willis had been with the Mexican petroleum firm since 1942. Survived by his widow, Luz F. de Willis.

Kenneth Tracy Winsor (1931–1958), pilot, U. S. Navy, Warrington, Fla., died in a plane crash in 1958. Born, Binghamton, N. Y., May 7, 1931. Education, BS(ME), Rensselaer Polytechnic Institute, 1954. Assoc. Mem. ASME, 1954. Survived by his widow who resides in Binghamton, N. Y. ●

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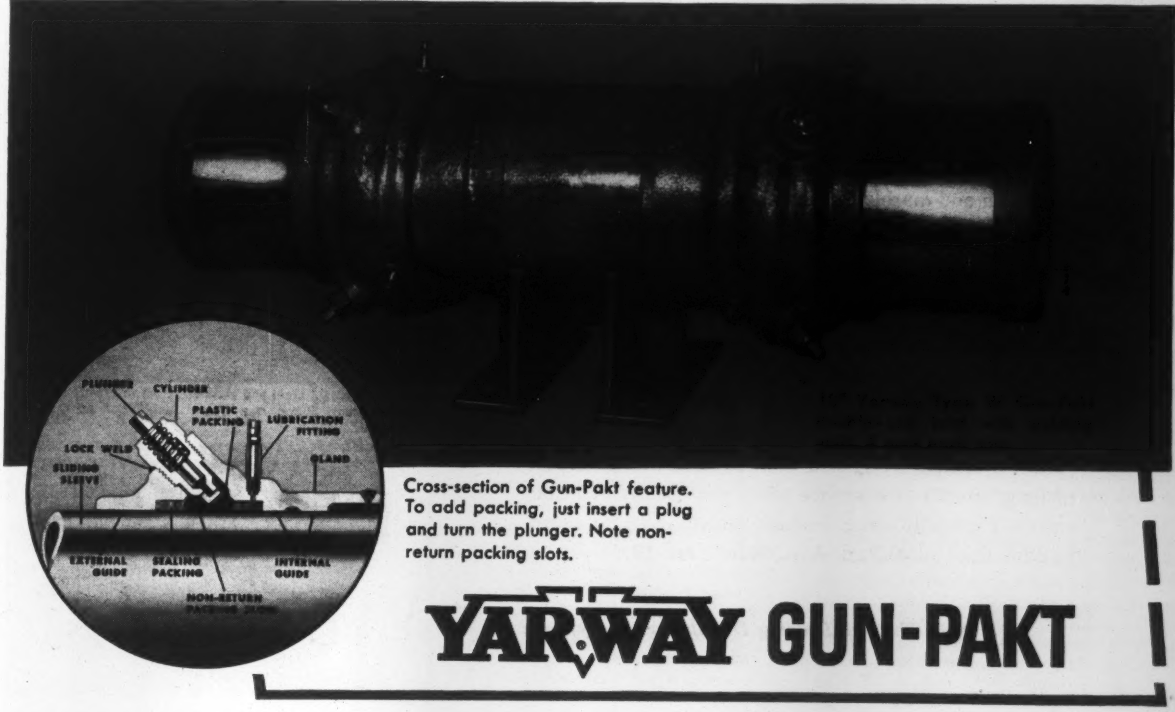

Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

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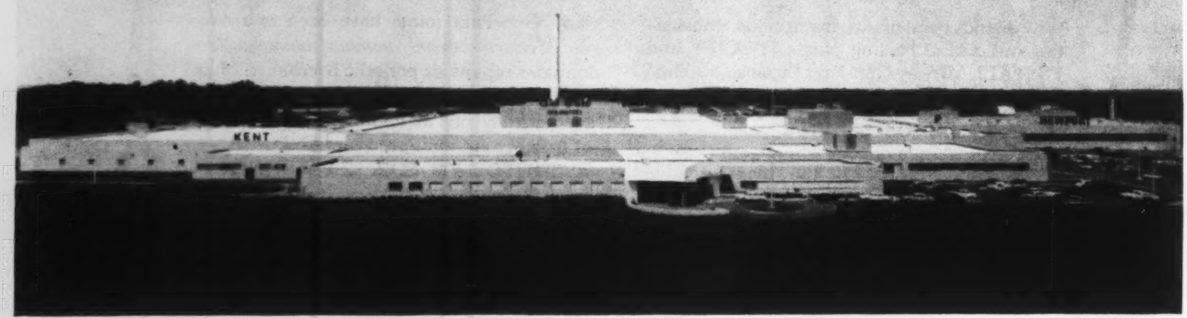

This plant covering over 600,000 sq. ft. produces famous Old Gold, Kent and Newport cigarettes in a completely automated process. Its most modern "climate control" involves refrigeration capacity equal to 120,000,000 lbs. of ice per year.

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Air-conditioning Contractor:
BUENSOD-STACEY, INC., New York, N. Y.
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You see it everywhere. In exterior surfaces of brick, aluminum and marble that need almost no maintenance. In walls of glazed tile and floors that are concrete or hard surfaced to reduce cleaning.

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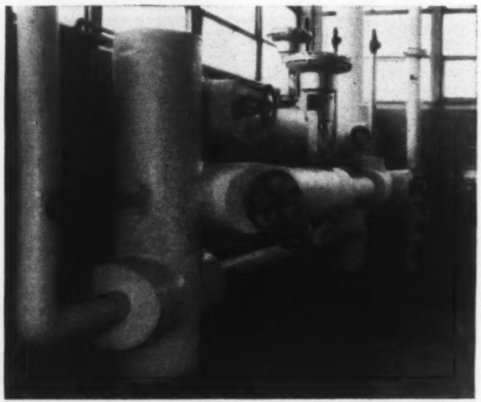

Jenkins bronze, iron, cast steel and stainless steel valves are standard in this modern plant. Shown is a typical installation on the main water supply line.

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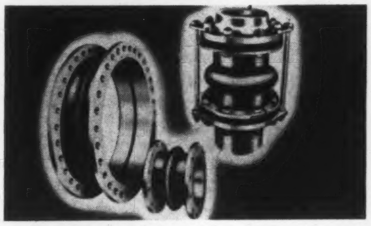


Expansion Joints

Expansion joints for chemical, oil, water or exhaust steam lines, operating at temperature 180 to 200 F, are available from Raybestos-Manhattan in sizes from $^1/_2$ to 78 in.

Designed for either pressure or vacuum operation, these joints are said to offer high strength and flexibility necessary to give protection from internal expansion and contraction, vibration, corrosion and erosion and compensate for misalignment.

The firm says the joints eliminate electrolysis, are not subject to embrittlement with age and offer maximum resistance to shock. The spool type expansion joints are especially compact and provide exceptionally long life even at elevated temperatures. Other types available are straight sleeve, Navy and Maritime Commission approved types. **—K-1**

Magnetic Sheet Fanner

A new and more powerful permanent magnet fanner designed to make the handling of sheet steel faster and safer, is announced by Stearns Magnetic Products.

The new sheet fanner employs a recently developed, oriented ceramic magnet material, Indox V. When steel sheets are stacked against the fanner, a magnetic field is induced in the sheets themselves, making them tend to repel each other and fan out automatically. The firm says handlers may remove single sheets easily and quickly and with far less danger of injury to hands.

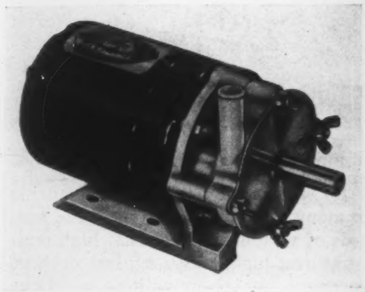
The new fanner is available in three sizes which, individually or in combination, will meet fanning requirements of all sheet stock sizes. **—K-2**

Needle Valve

A high pressure needle valve designed for pneumatic and hydraulic systems, utilizing a renewable glass filled Teflon seat to assure a bubble tight shut-off with hard to hold fluids from vacuum to 6000 psi, has been announced by Dragon Engrg. Co.

The valve is constructed of AISI 303 stainless steel with Teflon O-rings and a black plastic handwheel. The Model 816 can be panel mounted by removing the handle and the lock nut, then slipping the valve into a predrilled hole in the panel and reinstalling the lock nut and the handle.

According to the company, fine pitch regulating treads and a taper point on the stem combine to give excellent metering qualities as well as eliminate the pressure surge when opening the valve. Complete overhaul of the valve can be accomplished without removing the valve from the line, the firm states. Standard ports are female pipe NPT or female tubing AND 10050. **—K-3**



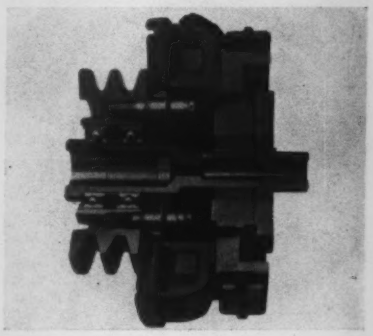
Circulating Pumps

March Mfg. Co. announces its Model 2X-35 sanitary circulating pump for fruit juice dispensers, ice makers, residential water cooled condensers, and for pumping photographic hypo, mild acids, liquid food, water, mild alkalies.

The unit has linear polyethylene pump housing and impeller; stainless steel cover and motor shaft; plus jumbo-size buna rubber lip seal.

Two motors are available: Model 2X-35 develops $^1/_{36}$ hp and Model 2X-20 is rated at $^1/_{20}$ hp. Both motors are air-cooled to insure minimum heat transfer to liquid being pumped.

The units are available with $^1/_2$ or $^5/_8$ in. OD inlets and outlets either straight or angles. Capacities over 400 gph now available. **—K-4**



Packaged Electric Clutch

Electro-Sheave, a combined electric clutch and sheave assembly for direct installation on all standard NEMA electric motor shafts, is announced by the Warner Electric Brake & Clutch Co.

Five sizes of standard clutch units rated from 1 to 25 hp are now in production. The firm says they can be applied on new equipment or used to modernize existing machinery.

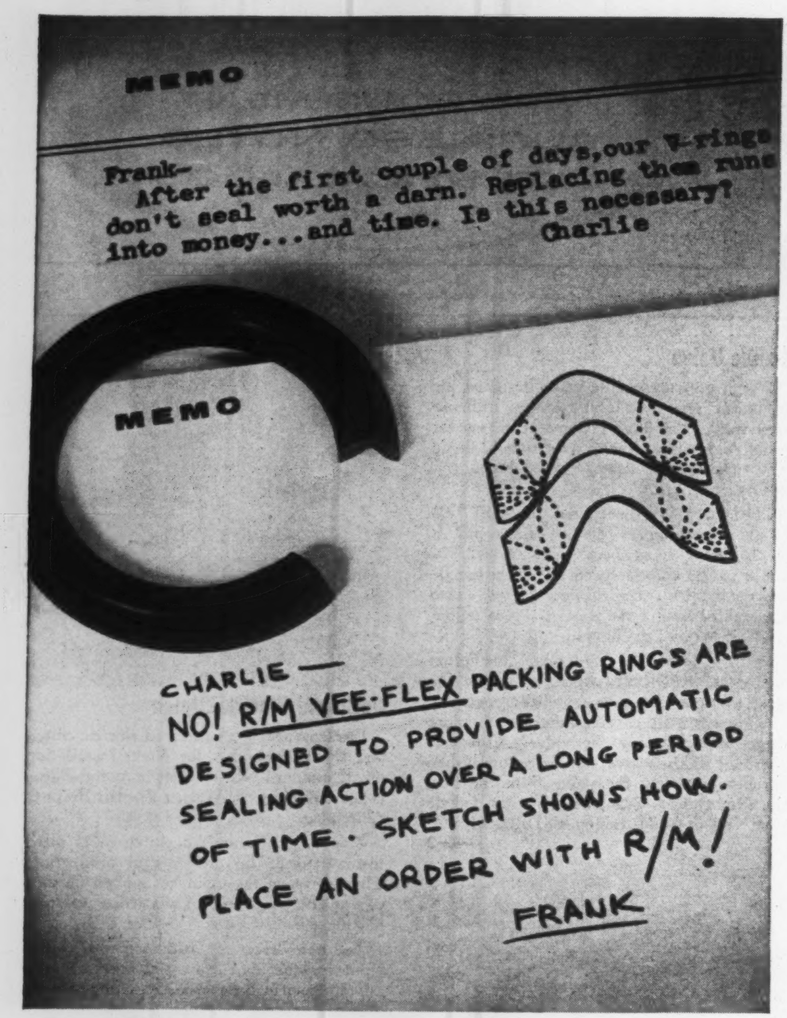
The new drives are said to permit equipment builders and industrial users to take advantage of electric no-load starting without the engineering, machining, and assembly costs usually required to adapt standard electric clutches to primary shafts. Electro-sheaves engage or release at any speed. For inching or jogging several starts are possible in less than one revolution of the clutch without what is considered normal wear and tear on motors, controls, or machinery. Release is instantaneous and the load is braked without plugging the motor.

Only a key and setscrew are required to install the unit in addition to making electrical connections to the clutch and brushholder from the control panel. The entire clutch and sheave is aligned and assembled correctly at the factory. **—K-5**

Rust Conditions Survey

A recent survey of 4000 chief engineers conducted by the technical services dept. of Rust-Oleum Corp., is available from the firm.

The survey reveals that 33 per cent consider weathering to constitute the most serious rust-producing condition; 14 per cent named chemicals; 13 per cent stated that humidity was the chief factor; and 10 per cent named fumes. Other conditions in order of importance were steam 9 per cent; heat 7 per cent; salt water 6 per cent; smoke 5 per cent and brine 4 per cent. **—K-6**



MEMO

Frank—
After the first couple of days,our V-rings
don't seal worth a darn. Replacing them runs
into money...and time. Is this necessary?
Charlie

MEMO

CHARLIE —
NO! R/M VEE-FLEX PACKING RINGS ARE
DESIGNED TO PROVIDE AUTOMATIC
SEALING ACTION OVER A LONG PERIOD
OF TIME. SKETCH SHOWS HOW.
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Ordinary V-rings, with their flat surfaces, provide little or no automatic sealing action against the walls of the cylinder, with the result they quickly lose effectiveness. This means, of course, loss of power and eventually a maintenance problem. R/M Vee-Flex Packing Rings are specially designed to solve it for you. Convexly curved surfaces where the rings meet and thinner cross section at the apex of each V cause a flexing action which makes a firm seal on the shaft and stuffing box wall and between rings

R/M Vee-Flex Rings are available in many compositions to meet the hazards of various applications: high temperatures, high pressures, fast cycling, corrosion, or combinations of these.

R/M's engineers have amassed a wealth of experience in manufacturing packings and gasket materials to meet the most exacting requirements of industry. This experience is at your disposal—call on R/M.

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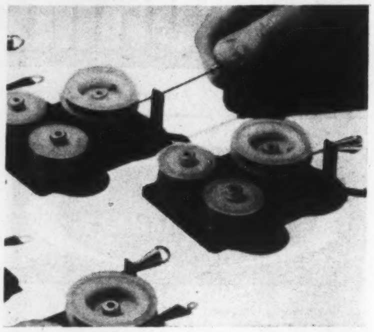


Spring Motors

Three new standard constant-torque Neg'ator spring motors have been made available by the Hunter Spring Co.

The units may be used as a design tool by engineers, or for actual application to counterbalance or retract light loads through long deflections without force build-up. The firm says earlier models have been widely used for tensioning electrical cable assemblies and the three new units are being offered in response to demand for similar motors having greater retracting force.

In contrast to the two previous stock model motors, which employ single springs and exert cable retracting forces of 6 oz and 1 and 2 lb respectively, two constant-force springs are used in each of the three new motors to provide increased output torque. Each stainless steel spring is mounted on a separate nylon take-up drum but both exert torque about a single, larger diameter output drum, upon which a pulley and its stainless steel cable are mounted.

The dual-spring motors have constant output torques of 2.33, 3.12, and 3.90 lb-in. throughout 15 revolutions of the output drum. They provide a constant retracting force of 3, 4, and 5-lb respectively, through the full 6-ft cable extension. Endurance of the new motors is 4500, 3000 and 2000 minimum complete operating cycles, respectively. All three motors have the same overall dimensions. Each is mounted upon a $2^1/_2 \times 3^3/_4$-in. black plastic base.

Because the two take-up spools overhand the base, the total width of the motors is 3-in. They are 1.2-in. high. A stop mechanism holds the stainless steel cable in the fully retracted position when not extended. **—K-7**

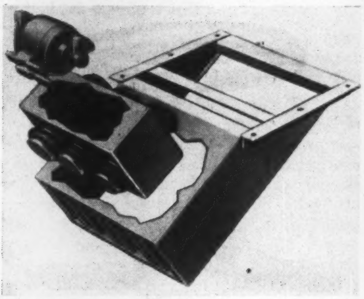
Precision Ball Bearings

PIC Design Corp., a Subsidiary of Benrus Watch Co. is offering a line of its Type E selected precision ball bearings, with a better than ABEC 7 tolerance.

The firm says that with bore tolerances selected to +.0000 −.0001, rather than the +.0000 −.0002 specified, the bearings permit better fit and less sloppiness in all precise instrument assembly applications. **—K-8**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Vibrating Feeder

An "Amplitrol" feeder, a new mechanical vibrating feeder with an exclusive pneumatic control system, is being introduced by Carrier Conveyor Corp.

Fully variable, stepless amplitude control, and the firm's exclusive natural-frequency drive are two primary operating features of the new feeder reported by the company.

The feeder is constructed with a heavy frame and single channel, steel trough, yet it is said to be extremely simple in design and easy to operate.

The drive unit is composed of a 900 rpm, a-c motor-exciter mounted between two banks of heavy-duty, industrial air springs. Motor-exciter and springs are set in a sturdy drive housing which can be mounted either above or below the trough.

Small offset weights are mounted on each end of the motor's double shaft. These weights are said to be very light compared to the exciter weights of other mechanical feeders. The motor size is governed by the size of the trough, and in standard models only $1/2$ hp is required to drive troughs up to 24 in. × 8 ft. The largest standard size, 60 in. × 8 ft uses 3 hp.

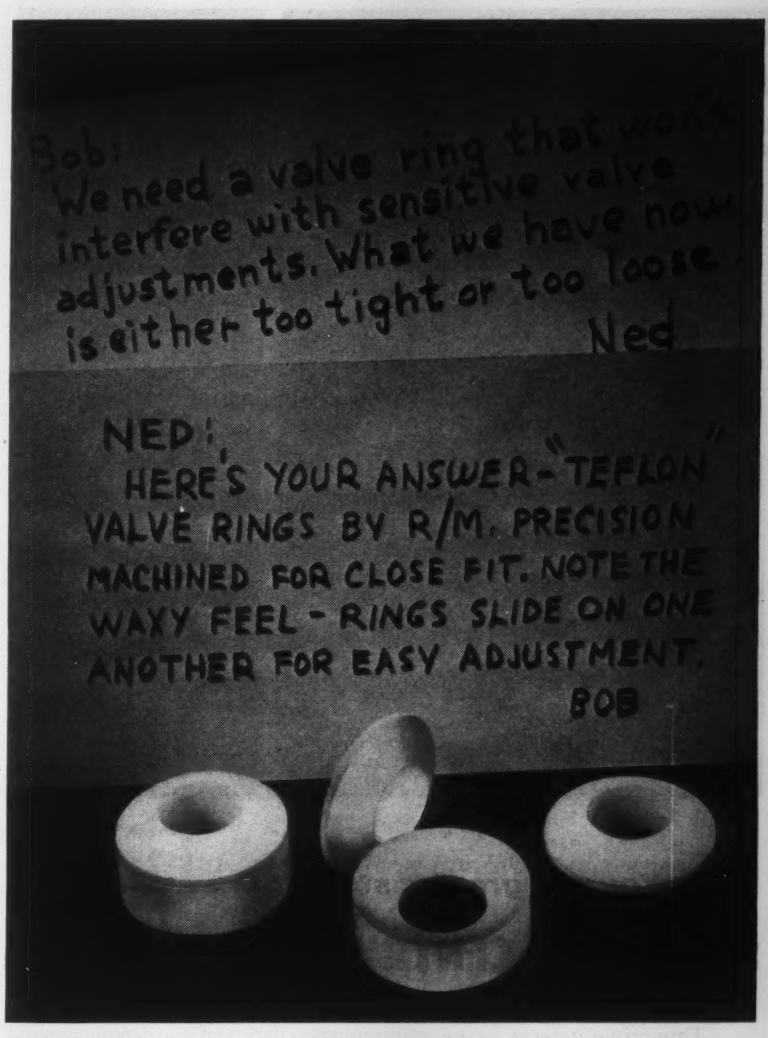
Dust-tight operation is provided by the totally enclosed, nonventilated 220/440 motors. The motors are built for vibratory service with pre-greased, sealed ball bearings.
—K-9

Pneumatic Instruments

Bristol Co. announces that its Series 663 Dynamaster instruments are now available in pneumatic transmitting models.

Potentiometers, pyrometers, a-c and d-c bridges, and differential transformer receivers with pneumatic output continuously transmit a 3-15 psig signal, the firm says. While retaining all the features of its electronic instruments, the pneumatic transmitting models are said to be especially suitable for use with the firm's Metagraphic pneumatic instruments.

The Model 663 is easily adapted to ratio, cascade, and computer-type control systems, and offers the plug-in convenience of the pneumatic line, the firm reports. —K-10



Bob: We need a valve ring that won't interfere with sensitive valve adjustments. What we have now is either too tight or too loose. Ned
NED: HERE'S YOUR ANSWER—"TEFLON" VALVE RINGS BY R/M. PRECISION MACHINED FOR CLOSE FIT. NOTE THE WAXY FEEL—RINGS SLIDE ON ONE ANOTHER FOR EASY ADJUSTMENT. BOB

"Teflon"* Valve Stem Packings are just what you need when you are making sensitive adjustments on slow moving rotary and reciprocating equipment. The precision machined rings slip on each other and exert pressure against the valve stem or rod. Because it does not react to any known chemical and has no known solvent, "Teflon" is ideal where corrosion is a problem. It has excellent nonadhesive properties—an added benefit if you are handling viscous fluids. "Teflon" Valve Stem Packings are supplied in wedge and angular type and as solid unit rings.

R/M also manufactures a complete range of homogeneous and reinforced valve stem packings engineered to meet many other requirements: high temperatures, high pressures, high speeds, temperature extremes, etc.

Feel free to call on the experienced R/M packing engineers for details and service, whatever your packing needs.

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS—including Vee-Flex®, Vee-Square®, Universal Plastic, and "versi-pak"®; GASKET MATERIALS; and "TEFLON" PRODUCTS. SEE YOUR R/M DISTRIBUTOR.

*A Du Pont trademark

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RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics • Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

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Downtime, rejects, heavy maintenance costs and too-frequent replacements can be cut down *appreciably* by the use of Shenango extra-strong centrifugal castings.

They provide a finer, *pressure-dense* grain . . . with all the weakening defects eliminated, such as blowholes and sand inclusions.

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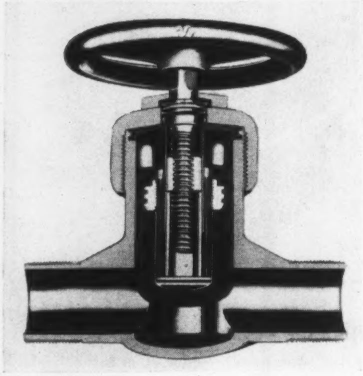

Plastic Valve

A new valve of all plastic construction has been introduced by W. S. Rockwell Co.

Employing a telescopic arrangement, instead of a diaphragm, a soft-rubber cup is forced to the concave bottom of the passage. Because of its flexibility, the cup under pressure from the stem, seals on all sides against the walls of the body casing, positively shutting off fluid flow, the firm explains.

On the upper part of the shut-off body there is a lipped packing which prevents the fluid from contacting the stem or from leaking out of the valve. The stem is located in two telescope type sleeves which slide inside each other. This also prevents ingress of the medium. A gasket prevents bearing grease from finding its way into the casing.

The outer telescope sleeve acts simultaneously as a pressure tube in the plunger, reinforcing the soft rubber cup from within. Material flowing through the passage under considerable pressure is not forced out to the side during closure. Thus, even under maximum pressure, the cup locates precisely in the position provided in the passage.
—K-11

White Control Panels

To match the white interiors of control panels as required by JIC and the general industrial trend, Panduit Corp. has developed a new all-white wiring duct.

According to the company, its high light reflectance allows greater internal visibility, making wire installation and tracing easier and minimizing visual fatigue. This feature reduces installation time, errors and production, the firm states.

The new Panduct is made of polyvinyl chloride plastic. It does not incorporate fiber fillers; therefore does not support fungus growth and will not irritate the hands of installers. It is available in any of nineteen standard sizes ranging from $\frac{1}{2} \times \frac{1}{2}$ in. to 3×4 in. It is available in the firm's open slot design as well as closed slot and wire hole designs. **—K-12**

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Variable Speed Pulley

A new variable speed pulley is now available from Lovejoy Flexible Coupling Co. to provide ratios up to 3 to 1 at $3\frac{1}{3}$ hp at 1150 rpm or 5 hp at 1750 rpm.

The firm says the pulley changes speed instantly with just finger-tip pressure while machine is in motion. Both pulley faces move simultaneously and equally to give constant belt alignment—each side independently actuated by its own spring. Curved pulley faces maintain full contact with belt sides at all times to provide maximum efficiency.

Known as the No. 3050 variable speed pulley, it uses a $1\frac{13}{16}$-in. top width variable speed belt. Standard bores are 1, $1\frac{1}{8}$, $1\frac{1}{4}$ or $1\frac{3}{8}$ in. with $3\frac{1}{2}$-in. bore length. Motor travel for full range is $4\frac{5}{8}$ in. with 9.53 in. max and 3.17 in. min pitch diam. Over-all dimensions are $10\frac{5}{16}$ in. long by 10 in. OD.
—K–13

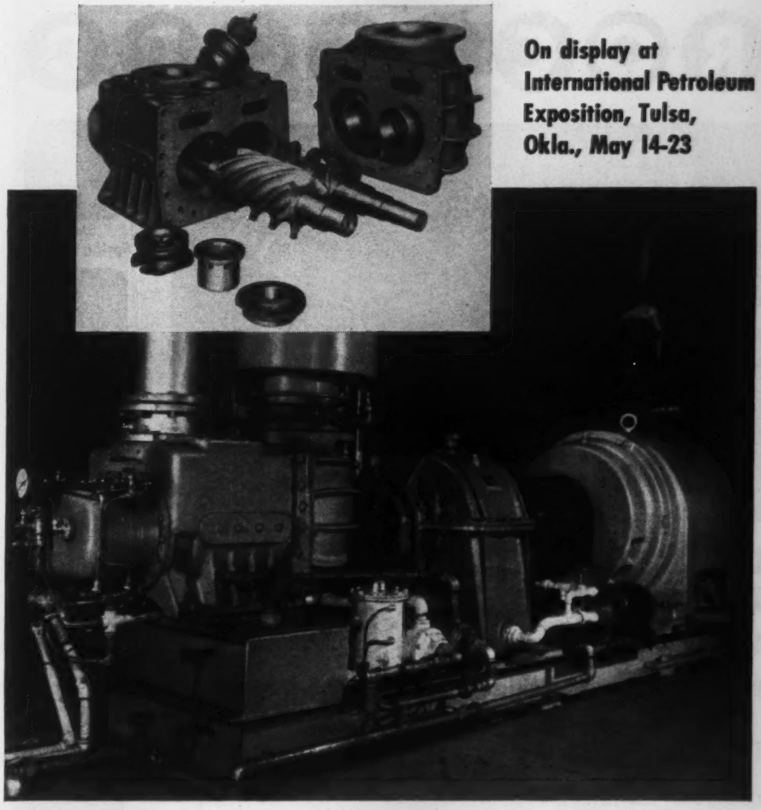
Stainless Fittings

Tube Turns Div., Chemetron Corp. has introduced a new line of light-wall stainless steel fittings and flanges designed for nominal-temperature, low-pressure non-critical process piping.

The new line, called Pipe-Mate, will be stocked in $\frac{1}{2}$ through 4 in. sizes, Schedule 5S and 10S, in the stainless steels grades best suited to corrosive applications in the large middleground area of roughly 150 psi or less, the company said.

The announcement said the new line features long tangents that permit easy alignment of fittings and pipe and allow clearance for fabrication of completely flanged elbows, returns, tees, and crosses.

A special feature of line is a novel swivel-type insert flange especially designed for ease of alignment. It is a carbon steel flange, and it has a stainless steel insert at the bore into which pipe or fitting can be expanded, then the carbon steel portion is simply rotated to line up the bolt holes and tightened. No welding is involved. Another feature of the new line is a reversible fitting.
—K–14



On display at International Petroleum Exposition, Tulsa, Okla., May 14-23

NEW *Fairbanks-Morse Positive Displacement Axial-Flow...*

Oil-Free Rotary Compressor

for pressure, vacuum or booster service!

Here is a mechanically-simple, precision-built, high-efficiency compressor that combines the best features of reciprocating and centrifugal designs!

The new Fairbanks-Morse Axial-Flow Rotary Compressor is a two-impeller helical-lobe type machine ...ideal for a wide variety of applications...smooth in performance, adaptable to any power source. Unit weights and space requirements are impressively low.

Standard models are available in single-stage units with capacities from 800 to 12,500 cfm. at compression ratios from 1.6:1 to 5.0:1—or in two-stage units with capacities from 2,000 to 12,500 cfm. at compression ratios above 5.0:1—and for booster service at maximum working pressures up to 250 psig.

Contact your nearby Fairbanks-Morse Branch, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.

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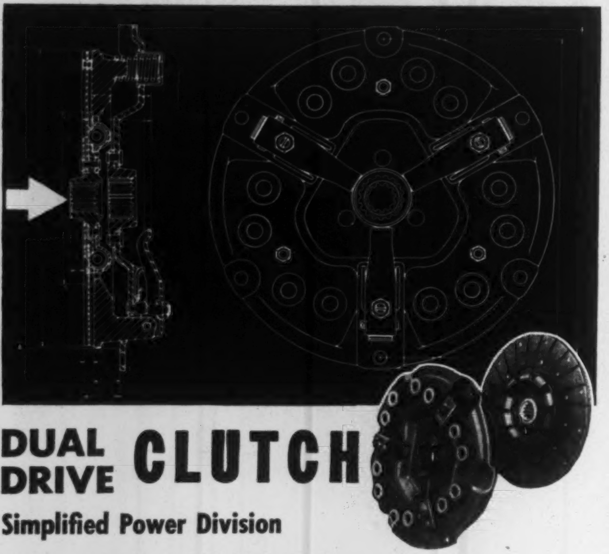
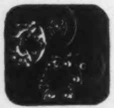
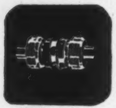
ROCKFORD

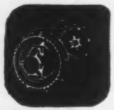


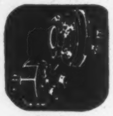

Small Spring Loaded

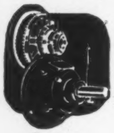
Automotive Spring Loaded

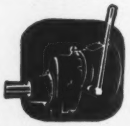
Heavy Duty Spring Loaded


Oil or Dry Multiple Disc


Heavy Duty Over Center


Light Over Center


Power Take-Offs


Speed Reducers

DUAL DRIVE CLUTCH

Simplified Power Division Between PTO and Vehicle Drives

This is a foot-controlled, spring-loaded clutch of rugged construction. It drives both the vehicle transmission shaft and the power take-off shaft. Power is transmitted to the power take-off by a hollow shaft, driven by a splined hub in the clutch cover plate. This hollow shaft operates at all times the engine is running. The vehicle transmission shaft operates inside the hollow shaft. This Dual-Drive design results in dependable control and transmission of full engine power to vehicle driving-wheels and power take-off.

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and
POWER
TAKE-OFFS

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CLUTCHES

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Chain Conveyor Flight

Chain Belt's Agricultural Chain Div., has announced a new development in agricultural chain conveyor flights called the positive lock flight.

The feature is a raised projection which immediately borders the top edge of the chain attachment on the trailing side of the flight. The firm says the projection is formed by blanking and prevents the chain attachment from turning on the flight—thereby insuring that the flight bar and chain will always be correctly positioned to carry ultimate loads. **—K-15**

Enclosures for Starters

Stainless steel enclosures, designed to resist the corrosive atmospheres of meat packing plants, tanneries, bakeries, and similar locations, are now available for Square D combination starters.

The new enclosures are built to NEMA Type 4 (water-tight) specifications, and are constructed of heavy-gage, AISI No. 302 stainless steel. Cover hinge bolts and associated hardware also are stainless steel. The nonferrous operating handle assembly and conduit hubs are chrome-plated. **—K-16**

Air Valve

Connor Engineering Corp. announces Pneumafoil, described as a revolutionary high velocity air valve which operates without motors or linkage mechanism of any kind.

Operation is by a 15 psi pneumatic control system. Each of the unit's airfoil type vanes encloses a sealed neoprene actuator connected to control air. The firm explains that as air pressure is increased, the actuators inflate and expand the vanes, constricting the open area between the vanes and throttling the air flow. When the expanding vanes make contact, complete shutoff with minimal leakage is achieved.

The company says airfoil type vanes minimize noise when throttling, and have low pressure drop in full open position. Their aluminum construction prevents corrosion.

For dual duct applications, two valves are mounted in a mixing box.

The valves are fabricated in 16 sizes which range from 10 × 6 in. to 32 × 24 in. Mechanical performance of large and small valves is identical, in contrast to large motorized valves which tend to overload actuating motors. Air capacities range from 1500 to 9600 cfm. **—K-17**

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Shock Testing Machines

Barry Controls Inc., has developed a new series of shock testing equipment designed to comply with pulse-defining specifications rather than the older equipment defining specifications.

The Varipulse machines, in specimen capacities of 100 and 400 lb, permit independent variation of the pulse with respect to its configuration, peak acceleration and duration. Accurate, uniform half-sine waves, saw tooth pulses and other special tailored wave shapes can be produced, the firm reports. **—K-18**

Pulse Traps Reduce Pulsations

Pulsation Controls Corp. announces the Pulse Trap for divided flow principle which attenuates the pulsations, cancels the pulsation of the two divided streams, which are forced out of phase.

The Pulse Trap is said to eliminate pulsation in liquid lines caused by reciprocating pumps. At pressures as high as 5000 psi, and temperatures to 650F. The liquid trap employs no gas chambers, synthetic rubber sacks or other devices. The device applies this principle to successfully eliminate as much as 99% of the pressure pulsating.

Pulse Traps are offered for gas transmission compressor stations, for application to eliminate differential meter error, and for refrigerant systems employing reciprocating compressors.

They are custom built in all sizes with pressure vessels for code requirements. Standard sizes are available for installation on the discharge of: Radial Piston Pumps—10 to 45 gpm—5000 psi 1150 rpm; Triplex Plunger Pump—10 to 45 gpm—3000 psi 400 rpm. **—K-19**

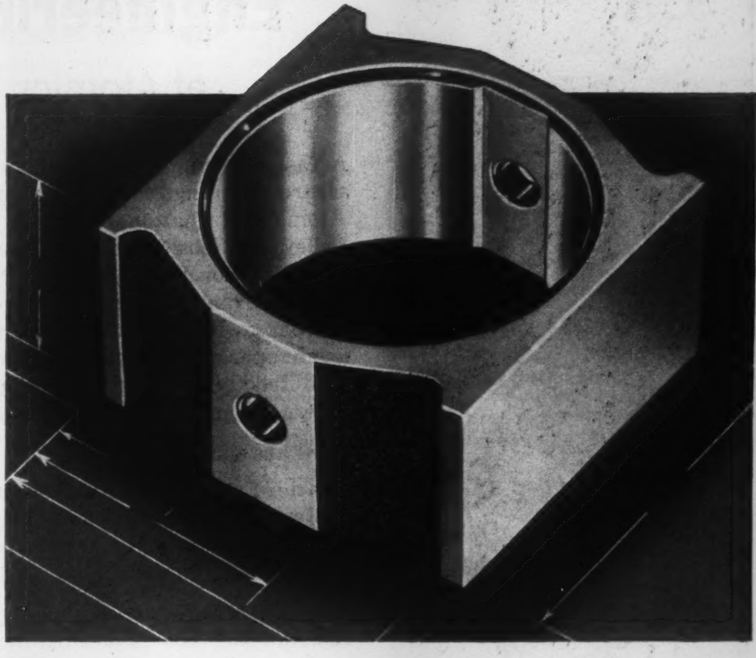
Trunnion Lubrication

A new automatic Lubritrol system to provide continuous lubrication for grinding mill trunnions and bearings has been devised by Allis-Chalmers.

Consisting of separate low- and high-pressure pumps driven by a common $^1/_2$-hp motor, the system is designed to make it unnecessary for the operator to provide lubrication while the grinding mill is running or during the critical cooling off and starting periods, thereby eliminating dry sliding between trunnion and bearing as the mill changes dimension.

The system's one pump continuously supplies oil directly beneath the trunnion at varying high pressures, depending upon whether the mill is rotating or at rest. This oil floats the trunnion in the bearing while additional oil under low pressure is deposited either at the top of the trunnion or incoming chamfer of the bearing to assure complete lubrication. Each mill bearing requires one Lubritrol system. **—K-20**

many difficult requirements...



We illustrate the cast bronze cam block for a hydraulic pump operating the hydraulic lift mechanism on an exceedingly well-known line of farm tractors.

The manufacturer of this equipment has very unusual specifications for this cam block. Its bore has a very fine finish specification. It also must be round and true to size within unusually close limits. In addition, it must be square to the face of the cam block within limits that ordinary methods of manufacture will not attain.

Bunting methods of manufacture result in a part which is completely to the customer's exacting specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered metal, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

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Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

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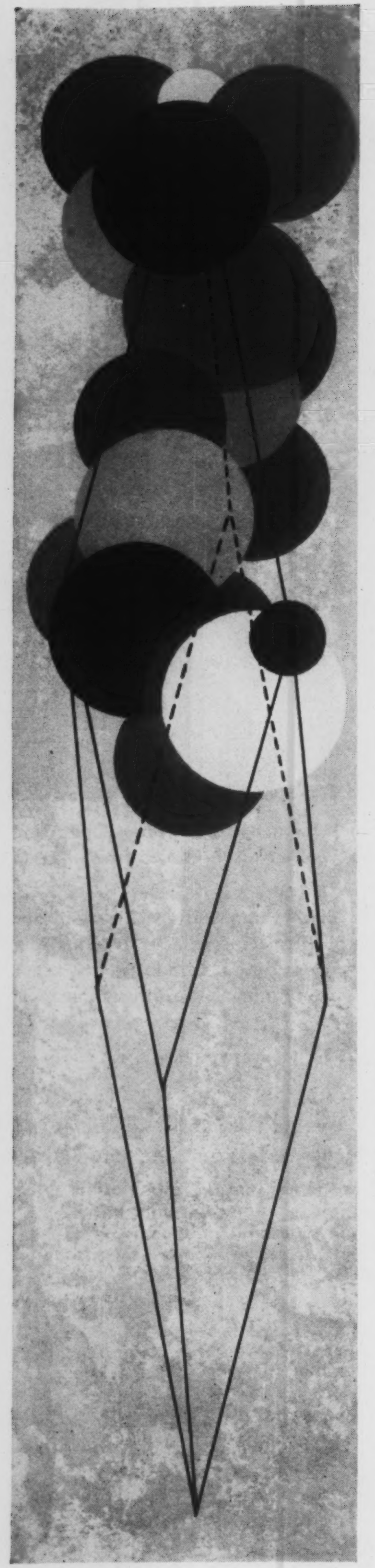
BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS



Opportunities in

Engineering Analysis

at Atomics International

A fast-growing backlog of major projects is creating future-assured openings for qualified nuclear scientists and engineers at Atomics International headquarters in the suburban San Fernando Valley near Los Angeles. AI is now developing a Sodium Reactor power station for Consumers Public Power District of Nebraska and an advanced type of power reactor for a group of fifteen utility companies in the Southwest. Overseas, five AI research reactors are in operation or under construction—and AI's Organic Moderated Reactor is one of the three power reactor concepts the Atomic Energy Commission has approved for export to Euratom.

Here are some typical current openings:

Reactor Engineering. Analysis and design of over-all power reactor systems and components. Prefer power reactor background in engineering design and analysis. Experience in reactor safeguard analysis also valuable.

Core Analysis. Complete nuclear analysis to include criticality, flux distribution, and reactivity requirements. Fuel cycle economics and optimization.

Shielding. Analysis and design of biological and thermal shielding of large stationary power plants. Advanced studies and methods analysis for compact and mobile power plants.

Heat Transfer and Fluid Flow. Steady state and transient experimentation and analysis. Power optimization studies; free and forced convection flow transients; boiling and two phase flow in water, organic and liquid metal systems.

Structures. Transient and steady state stress analysis of reactor components subjected to mechanical loads, thermal cycling, and thermal shock. Advanced analytical studies in thermal stress fatigue, elastic and inelastic behavior of plates and shells, structural dynamics, and electronic analog and digital computer application.

Control. Over-all power plant control including reactor kinetics and systems simulation. Experience valuable in plant protection systems, radiation monitoring, and control systems.

Write today for more details about exciting career opportunities: Mr. A. E. Newton, Personnel Office, Atomics International, 21600 Vanowen Street, Canoga Park, California.

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Fuel Materials. Senior Physical Metallurgists and Chemists for research and development of reactor fuels. Research in gas-metal systems, emphasis on structural, phase equilibria, and material properties.

Alloy development of fuel and cladding materials for operation in power reactors up to temperatures of 1200°F. and higher.

Study radiation effects, overall evaluation of uranium and alloys and ceramics.

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Irradiation Experiments and Hot Lab Evaluation. Senior Physicists, Chemists and Engineers to develop and conduct irradiation experiments to establish the behavior of fuel materials and prototype fuel elements under conditions of temperature and radiation anticipated in full scale power reactors. Also Senior personnel to develop techniques and equipment for the post-irradiation testing and evaluation of these experiments.

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Automatic Checkweigher

An automatic high capacity checkweigher, designed to check the weights of items from 50 to 200 lb, has been announced by Toledo Scale, Div. of Toledo Scale Corp.

This new Checkweigher will handle packages (depending on size) at speeds of up to 40 items per minute with an accuracy of approximately one part in 3000, the firm reports.

Equipped with a belt-type motorized conveyer on the weigh section, the Model 9460 provides 100 per cent in-line checkweighing. The unit continuously checkweighs bags, cartons, boxes, packages, blocks, cans or tubes with equal speed and accuracy without stopping the item on the scale, the company states. It may be conveniently and quickly adjusted to change from one package weight to another by resetting poises on the beams that are housed in a locked enclosure. **—K-21**

Sight Feeder

Jerguson Gage & Valve Co. announces a new high pressure drip sight feeder designed for use where drip feeding is required under high pressure, for corrosive conditions, for temperature conditions from below zero to 750 F, or as a small flow indicator.

The feeder incorporates a $^1/_8$ in. diam drip tube which extends into the upper portion of the chamber of a transparent-type flow indicator, thus making the drop formation easily visible to the operator. A valve with a needle stem is available as a hand-operated flow control valve. For low-temperature service the feeder is available in a patented nonfrosting design.

The feeder carries a pressure-temperature rating of 2000 psi at 100 F, 1100 psi at 750 F, and is available with $^1/_2$ in. or $^3/_4$ in. female or 1 in. male end connections; chambers and covers are rustproofed. **—K-22**

Portable Rotary Compressor

Ingersoll-Rand Co. announces the addition of a new 250-cfm size to its line of Gyro-Flo compressors. The new size will supersede the Gyro-Flo 210.

The manufacturer states the new unit, with a completely new compressor system, offers nearly 20 per cent more capacity in a unit that is smaller and more compact than its predecessor. It is driven by a larger, more-powerful engine, yet retains the same 1800-rpm engine speed. Fuel and air tanks are under housing and lockable cover. Full-length tool boxes are designed to give more storage, and side covers fold back safely out-of-way for inspection of compressor rotor valves.

The unit 250 offers a choice of two compressor-matched drives: the new General Motors 4-53 diesel engine or the Continental M-363 gasoline engine. It is available with 2 or 4-wheel mounting, or less running-gear for truck or skid mounting. **—K-23**

Heavy Ball Bearing

A new maximum capacity ball bearing, called Super Max, is now available for applications demanding sustained performance under especially heavy radial loads.

Made by Hoover Ball and Bearing Co., the bearing utilizes the maximum number of large-size balls that can be safely inserted in the bearing by way of an accurately placed filling slot. The firm says the design of the filling slot is such that the bearing will also carry combined radial and thrust loads where some thrust load-carrying ability is essential.

The bearings are made in light, medium and heavy series, and are available open or with single or double shields. Open and single shield models are also offered with a mounting snap ring. **—K-24**

Definitions of Occupational Specialties in Engineering

This book contains comprehensive data related to all activities and specializations in engineering including specific knowledge and duties, responsibilities and related techniques necessary for successful performance in each field.

The ten activity fields defined are research, design, development, testing, procurement, production, construction, operation, administration, and teaching.

Major engineering fields of specialization defined include aeronautical, automotive, ceramic, chemical, civil, electric and electronics, guided missiles, management, marine, materials, mechanical, metallurgical, mining, naval, nuclear reactor, ordnance and armament, petroleum and fuels and power plant engineering. Other engineering fields defined are: packaging, photogrammetry, agriculture, geology, and geophysics.

Pub. 1952 Price: $2.50, 20% less to ASME members.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th St., New York 18, N. Y.

NUGENT DUPLEX FILTER
keeps all the lube oil clean
for this Gas Turbine

The 7000 HP General Electric gas turbine shown above is destined for service in an East Texas chemical plant. A Nugent 1555BF-4L4 Duplex Filter is an integral part of the turbine system. Each filter comprising the duplex has a capacity of 150 GPM of 125 SSU viscosity lubricating oil. All the oil in circulation is filtered every cycle before going to the bearings. Foreign solids as small as 5 to 10 microns are removed; thus, harmful impurities cannot reach vital parts to accelerate wear.

Nugent Filters can lengthen the service life of your valuable equipment . . . reduce downtime . . . cut maintenance costs. Let us show you how. Write for information today.

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OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

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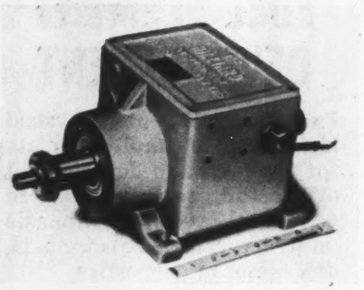


Intermittent Drive

A new, completely packaged machine that provides precise intermittent motion from a constant source of rotary power is being introduced by the Hilliard Corp.

The machine is called the IDU for Intermittent Drive Unit, the firm says, and the compact size allows it to be installed on existing equipment, designed into new machinery and re-used after production line changes.

All of the parts are totally enclosed in an oil bath housing. The single package unit gives precise control of any intermittent motions desired, clip and bend, shear or slash, oscillate or repeat, raise or lower, index and position.

The firm says the unit can be installed as easily as a motor and needs only electrical connection. Hand or foot operated equipment can be mechanized, existing power operated machines can be automated and it can be used as a building block in designing new machinery or production drives.—**K-25**

Roller Assemblies

Orange Roller Bearing Co. is now making available separate cage and roller assemblies from its standard cage type needle bearings, in 18 sizes from 1/2 in. to shaft diam, in a choice of two lengths for each shaft diam.

The assemblies are designed to meet space restrictions in applications such as idler gears, planetary gears, seaming rolls or any locations where shaft and housing surfaces can be hardened and ground.

They utilize 1/8 in. diam precision ground rollers, permanently aligned in pockets or bronze cages centered on the housing surface. —**K-26**

Pressure Regulator

OPW-Jordan has redesigned its 1/2 to 2 in. size piloted pressure regulator. A patented sliding gate and plate seats and new external sensing tubes, Teflon pilot seat, handwheel and thumlock, ball bearing adjustment are features of the new unit.

It is designed for pressures to 250 psi wsp and temperatures to 450 F, and is available from stock in bronze, cast iron, and ductile iron with screwed ends for steam, water, air, oil, gas, and chemicals. —**K-27**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Packaged Feeder

A compact new packaged feeder which can be installed in two steps has been developed by Fuller Co.

The firm says the new feeder is designed to facilitate the introduction of material into any kind of an air pressure conveying unit and can be adapted to small and large operations. It will handle any material which can be conveyed pneumatically, and will feed from bin, hopper, or conveyor, the company states.

After uncrating, the completely assembled feeder is put into position and the single air connection made. It is then ready to operate. It can either be hung from a hopper or supported on its own base or stand. It is available in $^1/_2$, $^3/_4$, and 1-hp units. **—K-28**

Cushioned Bushing

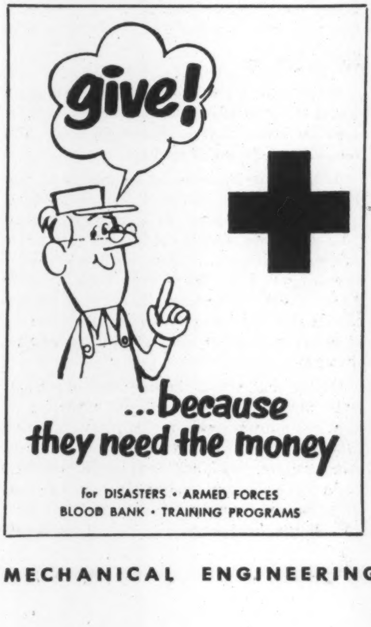
Ajax Flexible Coupling Co. announced a specification sheet covering the recently announced pin and rubber cushioned bushing, Series No. 400 low cost flexible coupling.

It gives specifications and ratings on the four sizes which accommodate $1^1/_4$, $1^3/_4$, $2^1/_4$, and $2^3/_4$-in. maximum bores respectively. **—K-29**

Welding Fittings

Walworth Co., a manufacturer of valves and fittings has recently completed negotiations with Midwest Piping Co., for the manufacture of Walworth welding fittings.

The company said the welding fittings complement its present lines of cast and malleable fittings and will be sold nationally through Walworth offices and distributors. The line is made from plate by an exclusive process. **—K-30**



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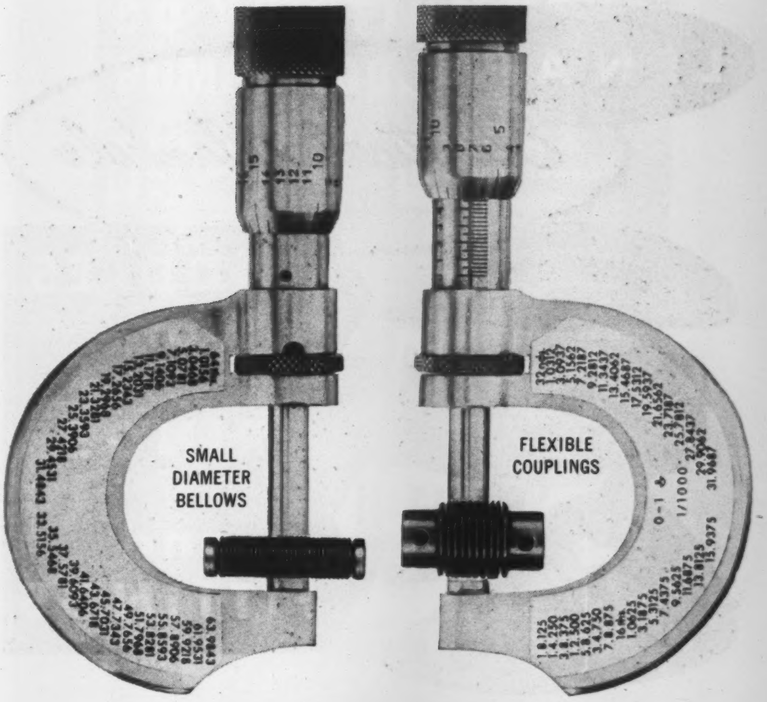

MINIATURIZE WITH Robertshaw

Looking for new ways to save space and weight in instruments, aircraft, missiles and other equipment? Investigate these two miniature products by Robertshaw:

Small Diameter Metallic Bellows, only ¼″ and $^5/_{16}$″ O.D., provide exceptional strength, precision and sensitivity to temperature and pressure changes. Hydraulically formed without seams to your strictest specifications in a wide range of bellows metals, physical properties and performance characteristics. Available in unlimited quantities.

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Small Diameter Flexible Couplings, available from stock, in several metals and sizes as small as $^{15}/_{32}$″ O.D. . . . smaller diameters custom-engineered on request. Eliminate back-lash, maintain uniform angular velocity, reduce bearing wear and friction in a variety of applications. Stock couplings accommodate shaft sizes ⅛″ to ½″ diameter.

WRITE FOR DATA SHEET D-805.

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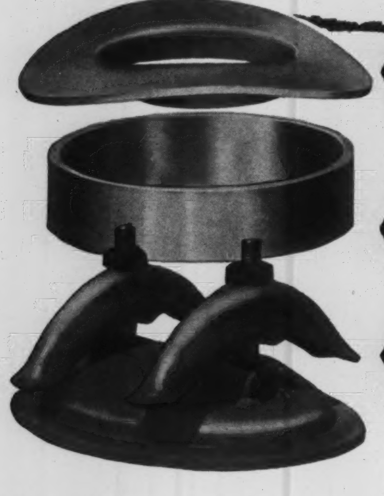
Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.



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For detailed specifications write today for Bulletin 565 or refer to pages 44-48 in Lenape Catalog 10-53.

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

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LENAPE HYDRAULIC PRESSING & FORGING CO.
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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Automatic Palletizer

A new automatic palletizer is being introduced by Miller Engineering Corp. for bag stacking operations in two- and three-shift plants.

The palletizer is said to be completely automatic and requires no operator. Each unit features either advanced Westinghouse Cypek automatic magnetic control system or standard relay controls. As a result, each stage of positioning the patterns and stacking is automatically controlled.

Any type of pallet—metal, paper or wood—may be used for stacking, the firm states. Its operating parts consist only of a motor-driven roller table, an elevator and an automatic ram. All reciprocating motions are designed to use the full stroke of hydraulic cylinders.

The roller table accepts and positions the bags. When a pattern is complete the roller table moves from under the pattern and automatically stacks it on the elevator below. The elevator descends one position as each layer of the stack is added. When a stack is complete an automatic ram pushes the stack off the elevator for pick-up by a fork truck or conveyor. **—K-31**

Appliance Switch

A compact new appliance switch that features high overtravel has been developed by Minneapolis-Honeywell's Micro Switch Div.

A special plunger mechanism provides a minimum of .200-in. overtravel without curtailing switch life, the firm states. Median mechanical life of the new switch (designated 6PL41) is over 2,000,000 operations at full overtravel, the company reports.

The switch can be mounted from the side or through a panel. It has a nickel-plated plunger and threaded bushing. **—K-32**

Air Cylinders

A new line of square-end double-acting air cylinders for holding, positioning, or moving work has been introduced by A. Schrader's Son, Div. of Scovill Mfg. Co.

Available in five sizes up to 4-in. bore, the JIC cylinders are designed for air pressure to 250 psi or hydraulic pressures to 750 psi. Each size is obtainable with or without adjustable cushion. There are five available mountings: bolt, flush, leg, base, or side flush. New square-end design and interchangeable mounting plates permit mounting in either parallel or 90 deg position relative to ports.

Design features of the line are: cartridge-type bronze bearing with self-adjusting U cup piston rod seal; ground, hard chrome plated piston rods with minimum yield strength of 125,000 psi; all-machined cylinder ends and mounting plates; and high tensile strength tie rods with 87,000–107,000 psi yield point. **—K-33**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

All-Electric Actuator

A new all-electric actuator is available from Conoflow Corp. manufacturer of final control elements. The Model D-62XW electric actuator is designed to provide economical automatic or remote manual positioning for throttling control of many types of valves, dampers, louvres, metering pumps, and speed changers. The firm says it can also be used for on-off remote pushbutton control with optional position indication.

The unit affords precise proportional positioning by means of a slidewire feedback used in conjunction with one of several voltage balance systems now on the market, the company states. It is available in a variety of travels from 1/2 to 4 in., with a maximum thrust of 700 lb. Stroking speeds are from 8.5 in./min at 100 lb load to 2.5 in./min at 700 lb load.

A continuously connected handwheel is designed to allow easy manual operation. Integral positioning stem and mounting yoke make the unit suitable for field mounting. —K-34

Fibrous Silicone Rubber

Connecticut Hard Rubber Co. has developed a new silicone rubber product called Cohrlastic FSR.

The development is described as a unique form of silicone rubber, fibrous in nature, somewhat resembling sponge and foam in properties. According to the company, the material is a mat of silicone rubber fibers, oriented in a completely random manner. This random orientation of fibers results in a product which has tensile and tear strength superior to silicone sponge and foam.

In addition to its improved mechanical strength, the inherent permeability of the material suggests applications which cannot be met by sponge or foam, the firm states.

The product is presently available from pilot plant equipment in sheets 1/4 in. thick, 9 in. wide and 6 ft long. It is anticipated that as applications are developed, Cohrlastic FSR will be made in continuous lengths, larger widths and various thicknesses. —K-35

Reducing Valve

A new steam pressure reducing valve employing an entirely new concept, mechanical pilot operation, has been developed by Leslie Co.

The firm says the new valve design employs a mechanical pilot device which is entirely out of the path of steam and therefore eliminates troublesome dirt catching and close fitting parts. Test of the valve performance compared with other types of steam pressure reducing valves show a flat capacity-regulation characteristic indicating close control throughout the operating ranges, the company reports. —K-36

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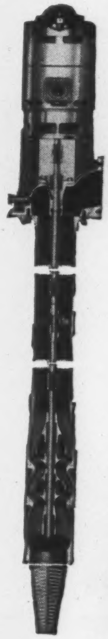
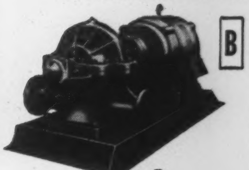
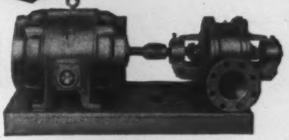




B **F-M Split-Case Centrifugal Pumps** Capacities, pressures and sizes for any requirements. Single-stage or multistage.

C



F-M Westco Peripheral Pumps Capacities to 200 gpm. Pressures to 900 ft. Sizes 1½" through 2½". Horizontal single-stage or multistage. Develops high pressure at normal operating speeds.

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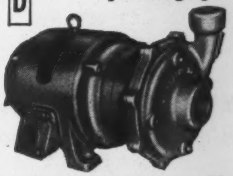

F-M Builtogether Centrifugal Pumps Capacities to 900 gpm. Pressures to 525 ft. Sizes ¾" through 5". Single-stage or multistage.

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Be *sure* of low-cost, foolproof pumping installations that match your exact requirements... call in your Fairbanks-Morse Sales Engineer. Take advantage of his broad technical background and expert knowledge of pumps for air conditioning, plumbing and heating. Call him today, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Flange Ball Valve

Worcester Valve Co. announces a flange ball valve designed to serve as either a 150 lb or 300 lb valve where conditions need not be answered by a valve of ASA dimensions.

The firm says that should ASA dimensions be required, the same center section, with the simple addition of an appropriate spacer becomes either a 150 lb ASA or a 300 lb ASA valve. The center section is inserted between two standard flanges and the flanges are bolted together. **—K-37**

Low Headroom Hoists

Robbins & Myers, Inc., Hoist & Crane Div., has introduced a new line of Type F3 electric hoists available in capacities from $1^1/_2$ through $7^1/_2$ tons.

The new hoists are said to require extremely low headroom. The 5-ton model requires 24 in. of headroom. Motor and control box on the hoists are totally-enclosed and weathertight. The addition of a simple, inexpensive diaphragm at the push button station makes the hoists suitable for outdoor use without the need of additional protection.

The new hoists are powered by a $7^1/_2$ hp, 30-minute, 55 C rise, totally enclosed motor with weatherproof brake. This new, totally-enclosed, magnetic motor brake is the multiple disc type and has extremely short stroke travel to prevent peening. **—K-38**

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MECHANICAL ENGINEERING—MAY 1959—Products Advertised

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MECHANICAL ENGINEERING—MAY 1959—Keep Informed Section

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Shape-Cutting Machine

A fully automated, unlimited-capacity shape-cutting machine has been introduced by Linde Co., Div. of Union Carbide Corp.

Known as the Oxweld CM-60 the new machine is described as the first American-made cutting machine to feature co-ordinate drive. It is powered by two electrically co-ordinated heavy-duty motors providing ample power for every type of flame-cutting operation.

The new unit can flame-cut intricate parts of any length, width, or thickness. Standard models can be equipped with 10 torches to cut any width up to 10 ft. Larger models cut shapes of any width and can be equipped with additional torches. The thickness of metal that can be cut is limited only by the capacity of the torches used, the firm reports.

The unit is claimed to be the world's first large-capacity cutting machine to be equipped with a photoelectric tracing system that automatically compensates for kerf width. **—K-39**

End Milling Tool

Brown & Sharpe, Cutting Tool Div. announces its new high-speed Thriftmill for profiling, slotting, peripheral milling and numerous other end milling operations.

The firm states that the new unit offers the buyer savings on initial purchase price of 15-20 per cent over conventional end mills.

The unit is being produced in the most popular end mill sizes. Volume production results in the following tolerances: Shank tolerance .000 to −.0005 and cutter diameter tolerance .000 to −.005. It has a 10 deg rake, 30 deg helix and is right hand cutting. It will be available at stocking distributors in 6 sizes, ranging from $^{1}/_{8}$ to $^{1}/_{2}$ in. **—K-40**

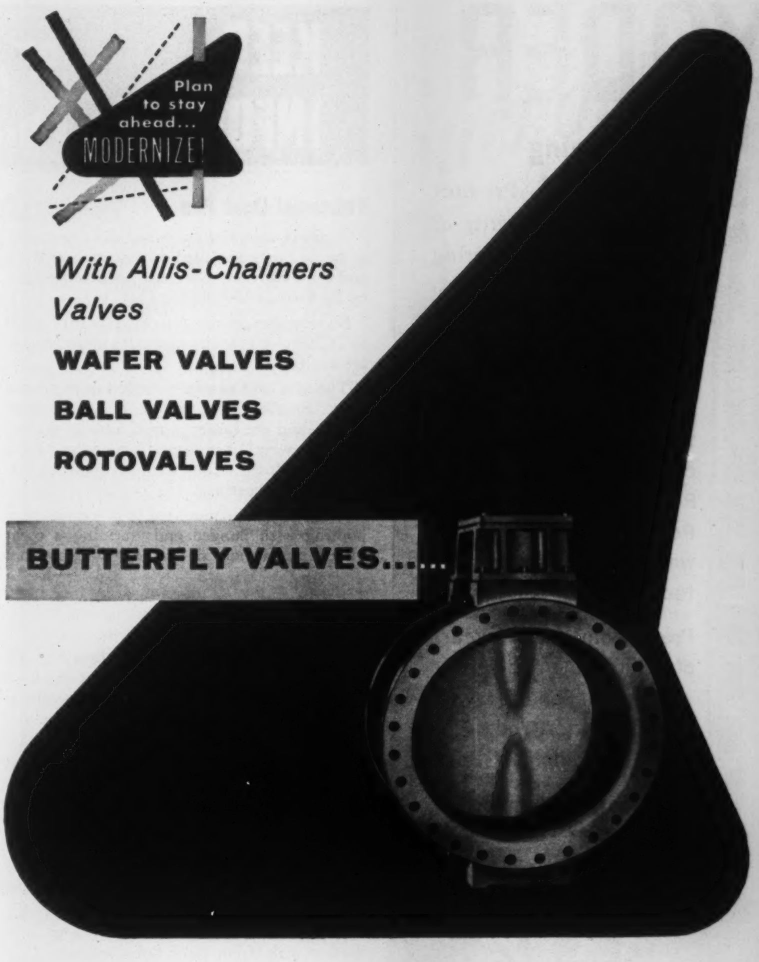
Blast Furnace Control

B-I-F Industries, Inc. recently introduced a new system for balancing the flow of blast air through the tuyeres of a blast furnace.

Enriched air, heated to 1800 F and blown through nozzles in the base of the blast furnace, controls the temperature and burning rate of the charge and provides oxygen necessary to burning. The firm says that with automatic control these difficult-to-control air blasts are made uniform despite back pressure and channeling. The results are said to be fewer hot spots and burned furnace linings, lower blowing costs, and prevention of valuable fines blown out the stack.

The controlling system consists of a flow nozzle, a balanced flow transmitter, a stacked diaphragm controller, a strip chart recorder, a 4-way valve positioner and a ceramic-lined butterfly valve—one set for each tuyere.

All control stations are cascade control systems, receiving the same flow control signal and master set point. In this way, the flow of air through all tuyeres is equal. **—K-41**



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To help solve your fluid and gas control problems, the broad line of Allis-Chalmers butterfly valves gives you:

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Minimum Pressure Drop Saves Power— In open position, the streamlined vane simulates Venturi action. Pressure drop is less than in many other valve types, helping to hold down your pumping costs.

Compact, Light Weight — Compact design and light weight permit more concise, space-saving layouts, cut construction and in-place costs.

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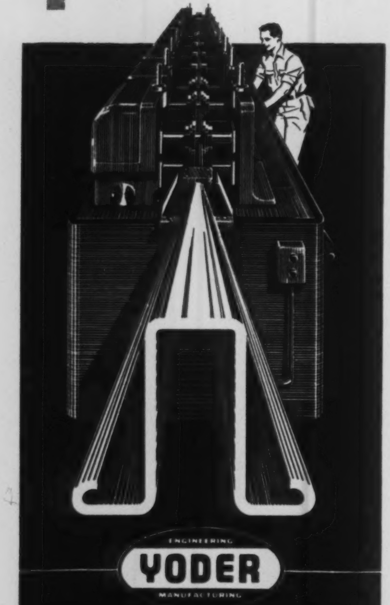

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(ferrous or non-ferrous)

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Tubeaxial Duct Fan

A newly designed tubeaxial duct fan, said to be as easily installed as a section of duct and using no more space, has been announced by Ilg Electric Ventilating Co.

Sixteen sizes, ranging in capacity from 1040 to 21,200 cfm at static pressures up to $1^{1}/_{2}$ in. are available.

The new unit can be mounted in any position. Smaller sizes feature a 3-blade propeller; and the larger, a new 5-blade design. The fan wheels are directly connected to a totally enclosed motor with permanently lubricated ball bearings.

The fan unit is mounted in a welded steel housing with flanged ends forming a completely prefabricated fan and duct section.

—K–42

Wall Bracket

A new pump support wall bracket, designed to hold a lubricant pump off the floor while drums are being changed, has been developed by Lincoln Engineering Co.

The bracket, of 16-gage sheet steel, zinc-plated to resist corrosion, eliminates the need for pump elevators or hoists. The operator merely hooks the drum cover flange on the bracket while he slides in a fresh drum of lubricant. Since the pump tube is held free of the floor, it cannot be contaminated by dirt, the firm reports.

The bracket includes two mounting holes, top and bottom, for securing to any type surface with $^{5}/_{16}$ in. diam bolts or screws.

—K–43

Mercury Manometer

Fischer & Porter Co. has issued Specification Sheet 13D1425 describing multiple electric contact mercury manometer which opens or closes successive electrical contacts with incremental changes in pressure of either a pneumatic signal or water.

The bulletin gives operating ranges, ratings, materials of construction, typical wiring, outline dimensions and other information.

—K–44

Gear Motor

Electro Products Div., Western Gear Corp. announces the design and manufacture of a 24 volt d-c centrifugally governed controlled three-speed gear motor.

The motor is rated at .1 hp at 1920, 1440, and 960 rpm with ± 1 per cent variation. It is a totally enclosed explosion proof motor designed for 500 hr life and built to meet the latest military specifications for camera and tape applications.

The firm says the motor is adaptable to a range of speeds in accordance with customer specified requirements. It measures $6^{1}/_{2}$ in. in length by $2^{5}/_{16}$ in. in diam.

—K–45

Vent Relief Valve

Aero Supply Mfg. Co. announces a vent relief valve is designed to release pressure on fuel tanks while they are being fueled, maintain pressure to permit redistribution of fuel load while in flight and admit outside air if tank pressure goes negative while in flight. Engine bleed air actuates this normally closed valve, the company reports. The unit has a molded nylon valve seat and employs a ceramic piston and cylinder with good tolerance for temperature extremes, a low friction coefficient, resistance to corrosion, and resistance to contaminated fuel.

The 1-in. line size weighs 1.3 lb. Fuel temperature range is from -65 to $+135$F; ambient range is from -65 to $+165$F. It is qualified in accordance with MIL-F-8615.

—K–46

Vacuum Gage

A thermal-conductivity-type constant-temperature vacuum gage having excellent sensitivity in two ranges, from 1 to 100 μ and from 1 μ to 500 mm, is now available from Consolidated Electrodynamics Corp. The gage, designated the Magnevac, has the broadest pressure range available in any thermal-type vacuum gage now in production, the firm claims.

No perishable components such as electron tubes are used in the circuit. A stable magnetic type amplifier not subject to the drift found in some other d-c amplifiers and offering the characteristic long life and durability of a transformer, is the heart of the units circuit. Silicon and germanium diodes are used in the circuit which operates satisfactorily in ambient temperatures of 50 to 104 F.

—K–47

Bronze Check Valve

A modernized bronze swing check valve of heavy-duty construction has been made available by the R-P&C Valve Div., American Chain & Cable Co.

It is recommended by the company for industrial applications of steam, water, oil, and gas service where back-flow must be prevented. It is, however, not recommended for pulsating services.

According to the firm, when the valve is fully open, there is only a slight restriction to full-flow. Generally used in connection with a gate valve, it may be installed in either a horizontal or vertical position.

The valve's disk is attached to a freely swinging hinge. Pressure in one direction swings this disk clear of the seat; pressure in the opposite direction forces it onto its seat.

The redisigned valves, manufactured in $^{1}/_{2}$, $^{3}/_{4}$, 1, $1^{1}/_{4}$, $1^{1}/_{2}$, and 2-in. sizes are rated for 125-lb saturated steam and 200 lb OWG. They are tested under hydrostatic pressure of 350 lb at the factory.

—K–48

VIGILANCE

The final victory over cancer will come from the research laboratory.

But there is a more immediate victory at hand today. Many cancers can be cured when detected early and treated promptly. *Vigilance* is the key to this victory.

There are certain signs which might mean cancer. Vigilance in heeding these danger signals could mean victory over cancer for you:

1. **Unusual bleeding or discharge.**
2. **A lump or thickening in the breast or elsewhere.**
3. **A sore that does not heal.**
4. **Change in bowel or bladder habits.**
5. **Hoarseness or cough.**
6. **Indigestion or difficulty in swallowing.**
7. **Change in a wart or mole.**

If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

**AMERICAN
CANCER
SOCIETY**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Speed Reducers

A new universal worm gear speed reducer that can be mounted in three different positions has been introduced by Link-Belt Co.

The units are available in $2\frac{1}{2}$, 3, $3\frac{1}{2}$ and 4-in. centers with up to $13\frac{1}{2}$ hp input rating and 7240 lb-in. output torque rating. They have three choices of mountings: worm shaft below gear, worm shaft above gear and output shaft vertical.

The firm says cost of horsepower has been reduced by using a one-piece cast iron housing with external fins for cooling and an aluminum radial fan which directs air over the fins. **—K-49**

Featherweight Nut

A light-weight, high-strength self-locking nut for use at elevated temperatures up to 900 F has been developed by Standard Pressed Steel Co.

The new nut, designated FN 920, has a tensile strength of 200,000 psi at room temperature and 150,000 psi at 900 F. It's designed for use with high-strength aircraft engine bolts having 0.003-in. reduced pitch diameter. On bolts of this type the FN 920 maintains locking strength after repeated reuse at temperatures up to 900, the firm reports. **—K-50**

Pressure Regulators

Atlas Valve Co., announces the availability of two new differential pressure regulators for steam service.

The first, Fig. 1200, Type C, controls atomizing steam pressure at an adjusted value higher than fuel oil pressure. The other, Fig. 1210, Type C, controls atomizing steam pressure at an adjusted value lower than the fuel oil pressure.

The valves, both available in sizes $\frac{1}{2}$ to 2 in. inclusive, have a minimum number of moving parts and require no internal adjustments. Of shear port design with honed guide, the 1200 and 1210, Type C, have telltale ports which indicate rupture of either steam or oil diaphragm. O-ring seals are suitable for 400 F. Their range of differential pressure adjustment is 5 to 45 psi. **—K-51**

Subminiature Switch

Haydon Switch, Inc., announces a new precision subminiature switch designed for operation under high temperature conditions.

It measures $\frac{3}{4} \times \frac{45}{64} \times \frac{23}{64}$ in., and is described as probably the smallest snap-acting high temperature switch available today.

The firm says special refractory materials are used in the construction of the switch to ensure stability of operating characteristics over the temperature range of −65 to +700 F, throughout the life of the switch. Life at rated load is 25,000 cycles at 700 F and 100,000 cycles at 450 F. **—K-52**

IT'S THE *MICROTOMIC* AGE

More and more engineers, draftsmen and architects are getting *a better feel of the future* at the drawing board with MICROTOMIC Drawing Pencils, the choice of professionals!

New, improved MICROTOMIC Lead Holder—

No. 607 — Positive-grip clutch...quick push button release. Scientifically balanced. Color-band tells lead degree.

Growing in preference—MICROTOMIC Drawing Pencil—

No. 603—with flat, adjustable eraser tip. Bull's-eye identifies each of 18 degrees.

New MICROTOMIC Drawing Leads—

No. 6100. One hand flip-top, pocket-size plastic box, *now with built-in sharpener.* 1 doz. leads. In 17 degrees.

Trademarks Reg. U.S. Pat. Off.

And for superior erasure qualities on special papers: drafting, tracing, vellums, plastic coated, it's RACE KLEEN Plastic Eraser—No. 521—soft, gentle, extremely pliable. Contains no abrasives. Double beveled.

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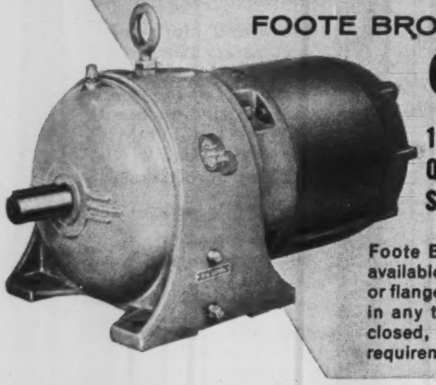
FOOTE BROS. **Motorized Drives**

Duti-Rated LIFETIME GEARING

Gives You More Power Per Dollar

FOOTE BROS.-LOUIS ALLIS

GEARMOTORS

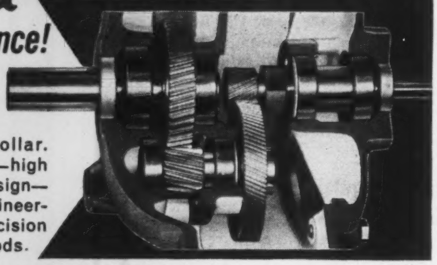


1 to 150 HP...Single, Double, Triple, Quadruple Reductions . . . Output Speeds from 780 to 7.5 RPM

Foote Bros.-Louis Allis Gearmotors are available in over 3500 types and sizes. Foot or flange mountings. Motors can be ordered in any type—open drip-proof, totally enclosed, explosion proof, etc. to meet your requirements.

Duti-Rated GEARING

Makes the Difference!



Duti-Rated Gearing is the heart of Foote Bros. Motorized Drives . . . drives that give you more load capacity and wear life per dollar. This is premium quality gearing—high hardness, accurate, balanced design—the product of thousands of engineering and development hours, precision tooling and manufacturing methods.

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1 to 75 HP...Double, Triple Reductions...

Ratios: 5:1 thru 238:1

Line-O-Motor Drives accept any NEMA frame motor . . . permit you to use your own motor or specify type to meet plant standardization. Foot or flange mounted.

MOTORIZED DRIVES

Write for CATALOG MRA. It has complete details and selection data on Foote Bros. Motorized Drives.

100 YEARS SERVING INDUSTRY 1859-1959 FOOTE BROS.

Better Power Transmission Through Better Gears

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

High Temperature Boiler

A new packaged high temperature water boiler has been developed by Boiler Engineering & Supply Co.

Called Flo-Kontrold, the new boiler is specifically designed for high temperature hot water heating and process work. Water is circulated at temperatures between 250 and 450 F with system loads from 4 to 100 million Btu per hr.

The firm says the design is basically about as simple as the standard residential hot water heating installation. Circuits are arranged to eliminate the possibility of vapor locking as there are no reverse vertical down flow tube circuits. All circuits are drainable at one point through the bottom header, and vented at one point through the top header.

Correct sizing of the orifice in the inlet end of each tube maintains the required velocity of water in each tube circuit. Each tube circuit has sufficient water due to metered flow to absorb the maximum amount of heat that will contact its surface.

The boiler is entirely supported on a structural steel frame and enclosed with a welded steel casing that is designed gas-tight for pressurized furnace firing. No special foundation or brick supporting construction is required, the company states. —K-53

Reflector Fixtures

Reflectors introduced by Stonco Electric Products Co. are available in standard dome, shallow dome, deep bowl or angle types up to 200 w and are designed for interchangeable use with the complete line of cast aluminum pendant, ceiling or wall vaportight fixtures.

Built-in vents encircle the entire fixture forcing a moving air-stream to flow continually through the reflector and out. According to the company, this air-conditioning action helps maintain cooler operation and longer lamp life while sweeping reflectors clean of dust and grime. Reflectors are vitreous fired porcelain bonded inside and out to heavy-gage coated steel in a bright, glazed procelain enamel finish. —K-54

Radial Bearings

Deep groove radial bearings for applications up to 900 deg F are now carried in stock in three R-series sizes by Industrial Tectonics, Inc.

The bearings are manufactured to ABEC-5 tolerances. Material for balls, races, and retainers is high speed tool steel. Retainers are machined, and of snap-in type construction. —K-55

For Consulting Engineers
Turn to Page 208

KEEP INFORMED

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Take-up Frame

A new take-up frame that permits the use of any pillow block is announced by Lovejoy Flexible Coupling Co. The firm says one basic frame size accommodates all types—ball, roller or babbitted, and it is the only frame now available that can be top or side mounted. This is accomplished by loosening a locknut, which permits swinging the flange connection either way.

A large nut is mounted on both ends of the adjusting screw, each ending with a heavy steel rod pin to permit disassembly and removal of all parts without special tools.

The adjusting screw is enclosed for protection against dirt, contamination. When lubrication or cleaning is desired, a quickly removed face plate gives access for this purpose.

It is called Versa Mount, and is claimed to be suitable for installation on new or old equipment. **—K-56**

Laminated Tubing

Two new grades of free-machining, paper base, laminated rolled tubing have been added to the Insurok line of laminates produced by Richardson Co.

Both grades meet Military specifications Mil-P-79B or Federal specifications L-L-31, Type 1. Typical properties of T-301 for a tube with 1 in. ID and 1/8 in. wall show 1 per cent water absorption, 19,000 psi compressive strength (axial) and a dielectric strength (perpendicular to laminations) of 400 v per mil minimum.

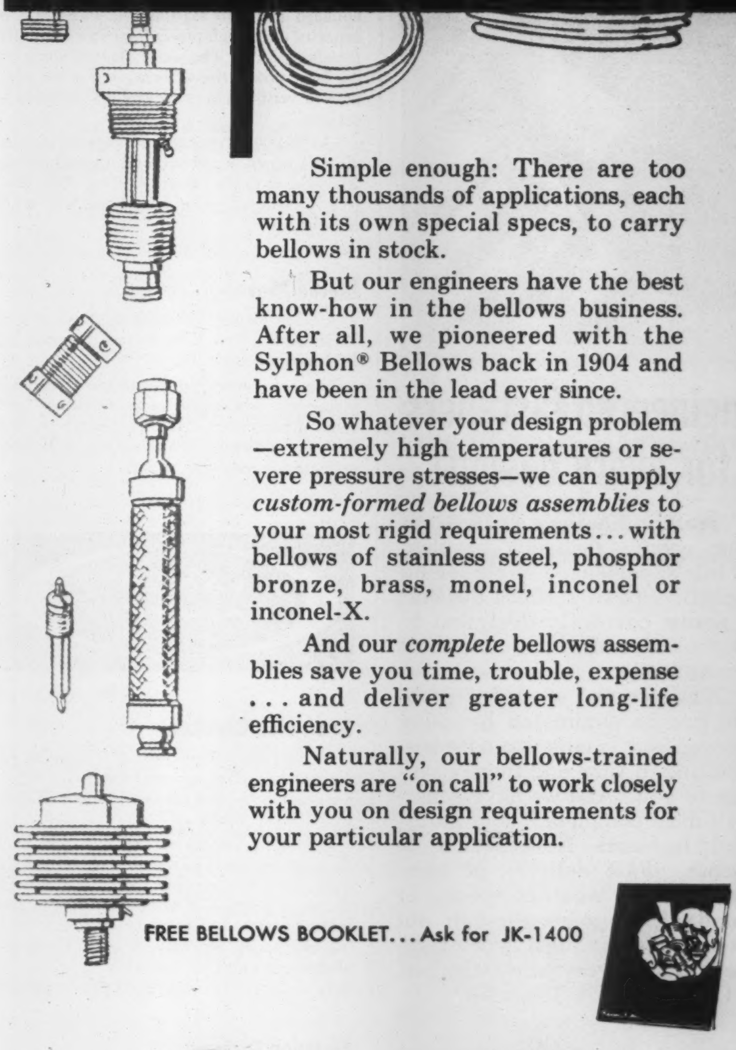
The firm says the new tubes are easily fabricated without delaminating or chipping. They have a uniform appearance, are light in color and are available in inside diameters up to 12 in. with wall thicknesses up to 2 in. and in lengths up to 48 in. **—K-57**

BUSINESS NOTES

Acme Adds Storage

Another 2800 sq ft of storage space has been added to the recently built Acme Chain Corp. plant at Holyoke, Mass.

The firm also reports that a battery of Perkins' heavy duty presses has just been installed for the assembly of No. 200, 2 1/2 pitch chain. The addition of this new size now gives Acme a complete line of precision roller chain, the company states.



Why We Never Have a "Clearance Sale" on Bellows . . .

Simple enough: There are too many thousands of applications, each with its own special specs, to carry bellows in stock.

But our engineers have the best know-how in the bellows business. After all, we pioneered with the Sylphon® Bellows back in 1904 and have been in the lead ever since.

So whatever your design problem—extremely high temperatures or severe pressure stresses—we can supply *custom-formed bellows assemblies* to your most rigid requirements . . . with bellows of stainless steel, phosphor bronze, brass, monel, inconel or inconel-X.

And our *complete* bellows assemblies save you time, trouble, expense . . . and deliver greater long-life efficiency.

Naturally, our bellows-trained engineers are "on call" to work closely with you on design requirements for your particular application.

FREE BELLOWS BOOKLET . . . Ask for JK-1400

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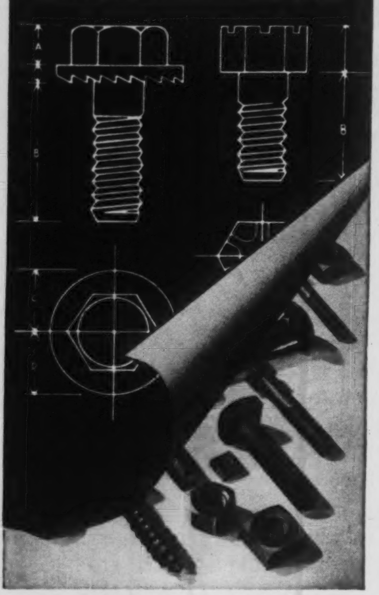
One order, one source
... every fastener need



Engineered fasteners for every design!

A careful, thorough analysis of your *specific* fastening problem by our experienced engineering department can produce the bolt or screw correctly designed to do your fastening job . . . most economically.

Often, we find a special problem can be eliminated by using one of our many standards—resulting in time and money savings to you. And we have America's most complete line of industrial fasteners from which to choose. Fast delivery of complete orders, whether special or standard, is yours through our modern plants, latest type equipment and convenient warehouses.

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Formerly Pittsburgh Screw and Bolt Corporation

America's Most Complete Line of Industrial Fasteners

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Opens Crane Office

Borg-Warner Industrial Cranes announces the opening of a new midwest district office at 2603 State St. in Alton, Ill.

Expands Test Laboratory

Westinghouse Electric Corp. has announced plans to expand and increase the capacity of its high power laboratory at East Pittsburgh, Pa. The facility is used for testing large power circuit breakers for the purpose of verification and development of new designs.

The $3,000,000 expansion program will begin this summer and will add approximately 20,000 sq ft to the present facility. The project is expected to be completed within 18 months.

Inertia Moves

A move to new, enlarged quarters at 311 West 43d St., New York, has been announced by Intertia Switch, Inc.

The new offices provide facilities for engineering, laboratory, administrative and sales departments. Inertia Switch is the designer and manufacturer of a new kind of acceleration-sensitive switch.

LATEST CATALOGS

Gear, Hob Checker

A four-page bulletin, No. 471, covering the various uses of its universal fixture for checking gears, hobs, and cutters has been released by Michigan Tool Co.

Among the various operations to which the checking fixture is suited are: checking axial lead of worms; outside radius and concentricity of worms and worm blanks; checking milling cutters and form tools for flute spacing, sharpening accuracy, depth of form, parallelism, eccentricity, and amount of form relief. **—K-58**

Flotation Systems

A brochure released by U. S. Hoffman Machinery Corp., describes flotation units employed in metal working operations.

By achieving continuous, fully automatic clarification of water soluble oil coolants, the units are said to increase productivity of machine tools, completely end down time due to failure of coolant supply and the need for sump cleaning. **—K-59**

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ME-5

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Aeronautical Research

Allied Research Associates, Inc., has issued a 10-page, two-color brochure describing its capabilities, fields of activity, management, and facilities.

The company's work in aerodynamics, applied mechanics, aircraft operations, chemistry, electronics and instrumentation, meteorology, physics research, systems engineering, propulsion, vibration, weapons effects, and weapon systems analysis are presented, along with brief descriptions of several laboratories. —K-60

Air Filter Products

A new 16-page composite product bulletin which contains a description of its complete line of products, has been released by American Air Filter Co.

Bulletin No. 518 illustrates and describes its products for air filtering, cooling, heating, cleaning (controlling process dust), moving, exhausting, humidifying, and dehumidifying air. —K-61

Industrial Trucks

Automatic Transportation Co. has published a new industrial trucks selector guide.

More than 150 models to fit all requirements are illustrated in this 20-page, two-color booklet. The selection factors, such as: capacity, frequency of use, power source, and use of semi-standard or special trucks are also given as a ready reference to all the firms's industrial trucks. —K-62

Solenoid Valves

Atkomatic Valve Co., announces Catalog No. 444, listing its line of 200 solenoid valves of bronze and stainless steel construction.

Valves are available for use with pressures from 0 to 10,000 psi and temperatures from −300 to +500 F and may be used for air, steam, corrosive, and noncorrosive gases and liquids. The 36-page catalog gives specifications, performance data, specific application information and optional features. —K-63

Butterfly Valves

B-I-F Industries, Inc. announces a bulletin describing its extended line of 125-lb class butterfly valves.

The bulletin contains information, cutaway drawings and photographs of the higher pressure butterfly valves, plus installation photos and information on choice of valve operators. Also included are dimensional data and cross sectional drawings of the valves designed for line sizes ranging from 4 to 48 in. —K-64

Extruding Machine

A bulletin covering a new wire insulating extruder which is said to feature 300 per cent faster speeds is announced by Jennings Machine Corp.

The units designed for production of Teflon-insulated wire by using unique new triple-pass vaporizing and sintering ovens. Features include interchangeable cylinders, guide tube microadjustment, rapid transverse motor. —K-65

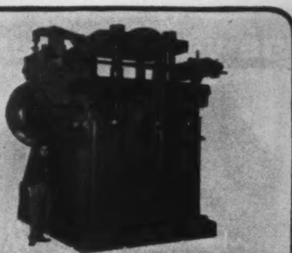
Fastener Application

A 16-page illustrated pocket-size booklet Helpful Hint published by Russell, Burdsall & Ward Bolt and Nut Co., contains technical facts on the application of standard fasteners.

Text points out how savings and stronger assemblies can be realized by proper fastener application. Information is contained on selecting the right grade of bolt, proper torque for bolts, bolt stresses, calculating proper bolt loading, tightening limitations, safety factor, threads, and protective coatings. —K-66

FIGHT CANCER
WITH A CHECKUP
(See your doctor)
AND A CHECK
(Send it now)
TO

AMERICAN
CANCER
SOCIETY



"WE RECOMMEND LUBRIPLATE FOR HENRY & WRIGHTS"

—says
The Hydraulic Press Mfg. Co.
A Division of Koehring Co.
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"We have had excellent results with LUBRIPLATE in our new double crank design Henry & Wright Dieing Machines which we recently acquired from Emhart Mfg. Co., Hartford, Conn. This follows the same fine results Emhart had with LUBRIPLATE in single crank Henry & Wrights for many years. In the Operating Manual that goes with every new Henry & Wright machine, you will find that we recommend LUBRIPLATE."

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose . . . LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

THE MODERN LUBRICANT
"It's the Film"
PREVENTS WEAR AND CORROSION
LUBRIPLATE
SUPER-LUBRICATION
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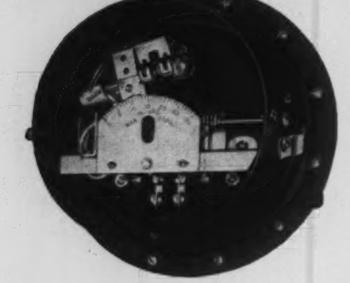
new instrument



FM APPROVED

LOW PRESSURE DIAPHRAGM CONTROL

For Air or Gases

This FM approved (Mercoid Type PG) control can be used three different ways; for positive pressure; negative pressure (vacuum); for differential pressure or vacuum.

OPERATING RANGE 1.0" to 30.0" (H_2O)

FIXED DIFFERENTIAL (Sensitivity)
When operating point is set at

Low	Med.	High
0.6"	0.8"	1.0"

MAXIMUM PRESSURE 20 psig

Equipped with Fairprene diaphragm, external adjustments, hermetically sealed mercury switch—case made of heavy gauge steel (NEMA 1)

Available fully automatic or semi-automatic with manual reset.

Write for Bulletin PG to The Mercoid Corporation, 4231 Belmont Ave., Chicago 41.

FM APPROVED

HIGH TEMPERATURE LIMIT CONTROL

Mercoid Type MX-51R for use with dryers, ovens, furnaces, etc. This adjustable indicating type high temperature limit control is actuated by a coiled bimetal element to result in a normally closed mercury (tube type) switch opening in event the supervised temperature reaches the preset limit point. A manual reset knob is arranged to reset mercury switch after high temperature operation and normal temperature restoration.

Operating Range (adjustable) 50-650° F. Minimum Differential 20° F. Electrical Rating 10A. 115V. 5A. 230V.

Has independent adjustments for setting both high and low operating points; visible calibrated dial; sealed mercury contact, reversible mounting flange. Case made of heavy gauge steel (NEMA 1)

Write for Bulletin SEB-51 to The Mercoid Corporation, 4231 Belmont Avenue, Chicago 41, Illinois.

SPECIFY

MERCOID® CONTROLS

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Shear Fasteners

Shear fasteners which are said to be as much as 70 per cent stronger than present aircraft standards are described in two new bulletins offered by Standard Pressed Steel Co.

The units are claimed to be capable of doing the job of aircraft fasteners one and even two sizes larger. The aircraft bolts and their companion locknuts are described as able to save as much as 50 per cent in shear-bolt weight alone, in aircraft and missile designs. Fasteners are offered in two series, for applications to 550 or to 900 F.

Shear strength options are the same in either series—132,000 or 156,000 psi. **—K-67**

Pipe, Vessel Covering

A 12-page illustrated brochure on Styrofoam pipe and vessel covering applications for low temperature insulation has been published by Dow Chemical Co.

The brochure presents engineering data, recommended application techniques and charts on recommended thicknesses and heat gain. **—K-68**

Aluminum Alloys

A new Reynolds aluminum mill products brochure gives specifications for the hundreds of alloys and forms of aluminum available from the company.

Starting with a description of the light metal's advantages over other materials, the 18 pages include alloy and temper designations, fatigue and shearing strengths, and various alloys available in foil, sheet and plate, wire, rod and bar, tubing and pipe, and extruded and structural shapes. Fabricating finishing techniques are summarized. **—K-69**

Metal Hose Connectors

Standard flexible metal hose connectors are illustrated, described and individually priced in a catalog published by Cobra Metal Hose.

The recently introduced line of wet heat connectors is included, along with specifications and installation information on flexible nipples, pipe, pump connectors, vibration absorbers, freon connectors, gas connectors, space heater connectors, dryer connectors, and water connectors. **—K-70**

Restrictor Valve

Fluid Controls, Inc., has announced availability of a new catalog sheet describing a unique restrictor valve which features a safety retention cap designed to prevent complete removal of the needle and blow-out of the stem.

The retention cap is said to eliminate the danger of the stem blowing-out and injuring personnel, yet in no way affects the convenience of the flow adjustment. The valve is designed to provide free flow in one direction and restricted flow in the opposite direction. Its design permits substantially increased flow capacity in the restricted flow direction and allows wider range of flow adjustments, the company states. **—K-71**

Hand Grinder

Chicago Wheel and Mfg. Co. has released a 12-page catalog on its hi-torque Handee and hi-power grinders and accessories.

The catalog gives information on the unit, its uses, operation instructions, and suggested applications. It shows mounted wheels, saws, brushes, cutters, drum sanders, and bands which are available for use with the hand grinders. **—K-72**

Bearings, Machine Parts

Wakefield Bearing Corp. has announced a 72-page catalog on oilless and self lubricating bearings, bushing, and machine parts.

Included are details about alloys and their recommended usage; properties of powdered metal compositions determined by tests; tables illustrating standard sizes of bearings available from tools already on hand; and a report of the facilities and equipment available from the firm. **—K-73**

Servo Mechanisms

Precision Mechanisms Corp. announces Bulletin No. 102-58, covering its line of pre-designed mechanisms and components for the servo and instrument fields.

An unlimited variety of geared mechanisms for use in breadboarding, prototype, and production applications may be assembled from the pictured components and the instructions in this bulletin, the firm reports. **—K-74**

Give
Fight
HEART FUND
HEART DISEASE

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Metals, Thermocouples

J. Bishop & Co. has issued three brochures on metals and metal products.

A 20-page booklet shows some of the end uses of small diameter stainless steel, nickel, and nickel alloy tubing; a new platinum products catalog is being distributed; and a brochure on thermo element wires covers applications of thermocouples. **—K-75**

Hard-Gear Finishing

Abrasive hard-gear finishing, a new process for correcting the heat-treat imperfections of external gears, is outlined in a four-page bulletin, No. 999, released by Michigan Tool Co.

The bulletin also covers machine construction and specifications, the economical finishing tools, and interchangeable equipment for finishing internal hard gears. **—K-76**

Precision Switches

A revised 24-page catalog covers the representative line of precision snap-action and mercury switches manufactured by Micro Switch Div., Minneapolis-Honeywell Regulator Co.

The catalog includes data on high-temperature, maintained-contact, explosion-proof high capacity, proximity, oil-tight, environment-free, and multicircuit types. Photos, dimensions, electrical ratings, characteristics, and application information are included. **—K-77**

Reducing Valve

A catalog sheet available from Atlas Valve Co., describes the new Fig. 1910, Type E reducing valve for initial pressures to 300 psi with gas, oil or water.

Outlet or regulated spring ranges are 5–35, 20–60 and 40–90 psi. Made of cast iron with bronze and steel trim, the valve is of single diaphragm, single seat construction and is said to have the largest capacity of any valve of its type. The valve is also made with a reverse seating arrangement to operate as a relief valve, 1910-R. **—K-78**

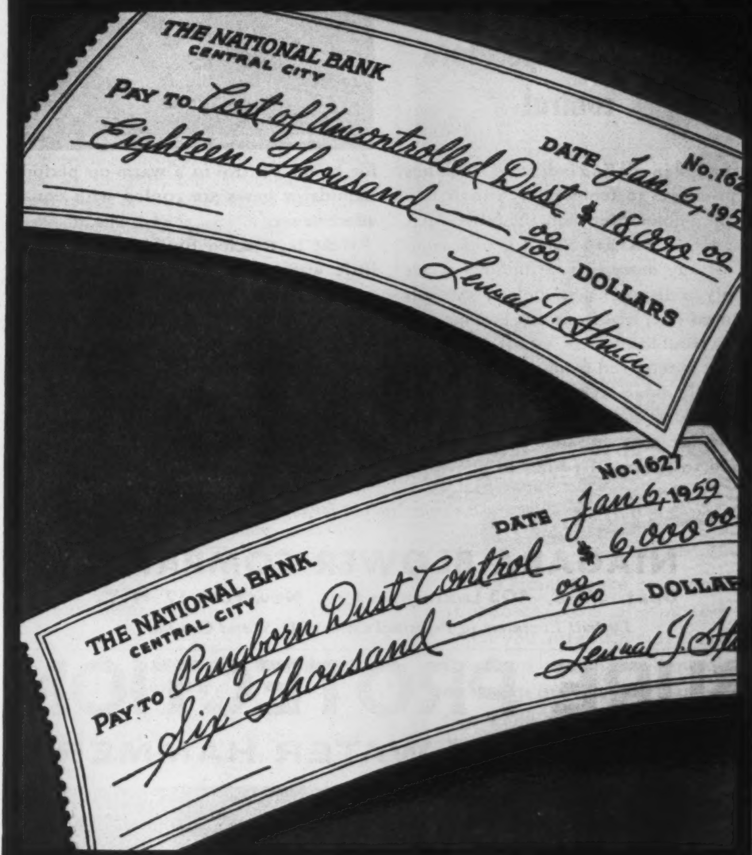
Inertia Switch

A new operating principle features inertia and impact switches described in a recent brochure published by Inertia Switch Div.

The switches have only one moving part: a precision-ground ball bearing normally held open by a tiny magnet. The switch is sensitive to acceleration axially, radially, or omnidirectional from 0.01 g to 500 gs. Accuracy is stated to be within 0.1 per cent, repeatability within .003 per cent.

The switch is miniaturized and weighs about 1 oz. Automatic reset is optional; closure time is variable. The switch comes with adjustable g setting if desired. **—K-79**

WHICH CHECK WOULD YOU RATHER WRITE?



THE NATIONAL BANK
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No.162
DATE Jan 6, 195
PAY TO Cost of Uncontrolled Dust $ 18,000 00
Eighteen Thousand — 00/100 DOLLARS

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PAY TO Pangborn Dust Control $ 6,000 00
Six Thousand — 00/100 DOLLA

How much are you paying for uncontrolled dust?

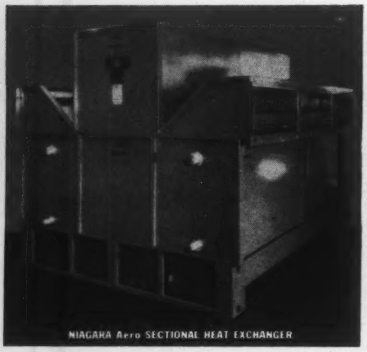
See for yourself—add up the cost of your lost salvageable material, housekeeping expenses, excess machine wear, intangibles such as community and employee goodwill. Whether your total is moderate or high, Pangborn Dust Control will cost you *less* than uncontrolled dust.

For details on Pangborn's engineering knowledge and experience, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2000 Pangborn Blvd., Hagerstown, Maryland. *Manufacturers of Dust Control and Blast Cleaning Equipment — Rotoblast® Steel Shot and Grit.*

Pangborn CONTROLS DUST

This Self-Contained Fluid Cooling System

... gives most accurate temperature control



Applied in cooling industrial machines or processes to temperatures approaching the ambient wet-bulb, the NIAGARA *Aero* HEAT EXCHANGER is independent of any more than a nominal water supply or disposal. The coolant system is a closed one, free from dirt and maintenance troubles.

Heat is removed from your process *at the rate of input,* giving you precisely the temperature you require and assuring the quality of your product. Heat may be added to prevent freezing in winter or for better control in a warm-up period. Liquids or gases are cooled with equal effectiveness.

Heat is rejected outdoors. Only the little water evaporated on the cooling coils in the air stream, or discharged to prevent hardness build-up, is consumed.

Niagara sectional construction saves you much installation and upkeep expense, gives full access to all interior parts and piping. Your equipment always gives you full capacity and "new plant" efficiency.

Write for Niagara Bulletin No. 132 for complete information

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SURE PROTECTION

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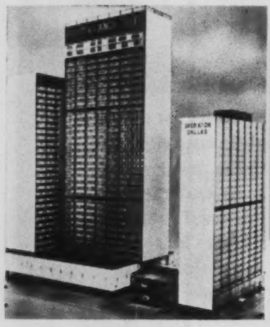
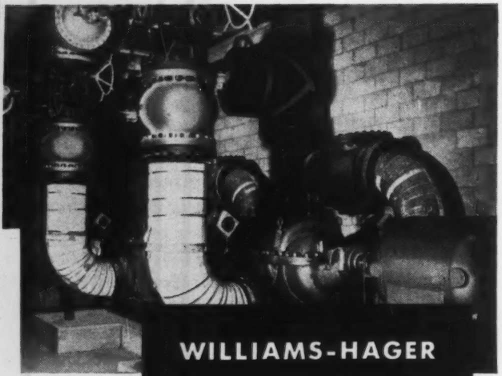


Architects and Engineers
Welton Becket, FAIA and Associates
General Contractor
J. W. Bateson Co., Inc., Dallas
Mechanical Contractor
Farwell-Wallace, Dallas



WILLIAMS-HAGER *Silent* Check Valves

At the dramatic new *Southland Center* in Dallas, 57 Williams-Hager Silent Check Valves protect the plumbing, heating and air conditioning systems from surge pressures and resulting water hammer. *Write for Bulletins: No. 654 on the Valves, No. 851 on Cause, Effect and Control of Water Hammer.*

THE WILLIAMS GAUGE CO., INC.
149 Stanwix Street
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Our 73rd Year 1886-1959

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Spring Steel

A 43-page spring steel stock list is now available in booklet form from Uddeholm Co. of America.

The book lists all standard sizes stocked by the firm in a variety of Swedish cold rolled spring steels including: blue tempered and polished clock spring steel, band saw steel, tempered flapper valve steel, tempered shock absorber steel, thickness gage steel, doctor blade steel, scaleless blue tempered spring steel, annealed spring steel. **—K-80**

Breather Filters

Data sheet No. 101 describing a line of 40-μ breather filters for free flow of clean air into hydraulic fluid, fuel, and oil reservoirs is now available from Bendix Filter Div., Bendix Aviation Corp.

The sheet includes photographs, air-flow pressure drop curves, operating description, cross section drawings and specification tables. **—K-81**

Photo Reproduction

A four-page illustrated folder describing the features and accessories of Keuffel & Esser Co.'s Micro-Master 105mm photo reproduction system for engineering drawings is available for distribution.

The folder describes how the system reproduces almost any size drawing, restores smudged or worn originals to almost perfect legibility, guarantees distortion-free accuracy, and by producing permanent negatives of "archival quality" allows economical establishment of a disaster storage file. **—K-82**

Shipping Containers

A bulletin published by National Vulcanized Fibre Co. presents the company's new line of Kennett vulcanized fibre reusable shipping containers.

The four-page bulletin describes the three basic types of containers in the line—standard padded, dunnage board, and shock cradle—and tells how they are used for such equipment as radar units, gyroscopes, scientific instruments, electronic apparatus, and other shock-sensitive components and equipment. **—K-83**

Tramrail Engineering

A revised issue of its tramrail engineering and application booklet, No. 2008-N, has been issued by Clevelend Tramrail Div., Cleveland Crane & Engineering Co.

Detailed studies of track design, peening, and stresses are given. Also covered are various types of carriers, cranes, tractors, track switches, buckets, grabs, and electrification. Photographs illustrate a variety of overhead materials handling installations. **—K-84**

Looking for latest available data on types, sizes, purposes and facilities of research and test reactors? Then consult the book entitled,

RESEARCH AND TEST REACTORS

Vol. 2, of Nuclear Reactor Plant Data.

Here will be found specific information on fifty-three research reactors located in the United States and forty-two reactors situated in Canada, South America, Western Europe, Asia and Australia, which was furnished by responsible persons associated with the respective projects, and which includes as many of the following details and technical data as were available.

General: Reactor Location and Type. Owner, Operator, Designer, Constructor. Cost of Reactor Facility. Operating Staff. Annual Operating Cost. Status. Design Power. Normal Operating Power, Power Density, and Specific Power. Operating Schedule. Principal Use of Reactor. To Whom Available for Research? **Fuel:** Normal Fresh Fuel Loading. Total Fuel Inventory. Expected Average Burnup Before Reprocessing. Fluid Fuel. Solid Fuel. Method of Refueling. **Reactor:** Over-All Active Core Dimensions. Core-Containing Vessel Dimensions, Materials and Mean Operating Pressure and Temperature. Moderator. Reflector Thermal Shield. Biological Shield. Reactor Control. **Primary Coolant:** Fluid. Circulation. Heat Dissipation Method. Average Core Heat Flux. Ratio of Maximum to Average Heat Flux. Means of Purification. **Nuclear Data:** Fuel Loading. Fluxes. Reactivity Coefficients. Burnable Poisons. **Research Facilities.**

Data collected on each reactor are presented on a separate three-page form, the latter having been specially designed to facilitate their use.

Additionally, there are diagrams of reactor facilities, notes on special features, and other supplementary material.

Published, March 1959, 304 pages. 8½" x 11". $7.50 a copy, 20% discount to ASME members.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Single Bridge Cranes

An eight-page folder, designated Bulletin DH-445B, and describing the type B-514 top running, single bridge, motor-driven cranes has been issued by the Wright Hoist Div., American Chain & Cable Co.

Offered in capacities from 1 to 10 tons, with spans up to 50 ft, and in standard bridge travel speeds of 75, 125, and 175 fpm, these cranes are said to be satisfactory for all floor-controlled industrial applications. **—K-85**

Hydraulic Pumps, Motors

Pumps and motors designed specifically for high temperature hydraulics systems is described in a four-page color brochure issued by Pesco Products Div., Borg-Warner Corp.

Ratings show speeds to 24,000 rpm, with efficiencies to 94 per cent. Among the features of the units included are special valve-plate porting, constant velocity universal joints, spherical pistons with line contact rings, and allsteel construction. Both single and dual elements units are listed, and detailed drawings and photographs are used in the illustrations. **—K-86**

Liquid Level Indicator

Bulletin WG-1824, Supplement B, issued by Yarnall-Waring Co., describes new miniature transistorized secondary liquid level indicator.

Information on where it is used, how it works, construction details, advantages, weight, dimensions, and an installation diagram are included. **—K-87**

Marine Steam Generator

A revised specification data sheet on marine packaged generators has been issued by Cyclotherm Div., National-U.S. Radiator Corp.

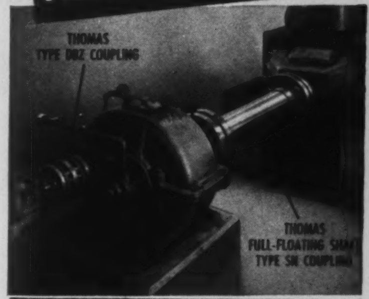
The sheet covers the minimum specifications for a Cyclotherm unit which has been developed specifically for shipboard installation. According to the company, it occupies to two-thirds less space than conventional steam generators because of its 2-pass, Scotch marine type construction. **—K-88**

Overhead Conveyor

Conveyor Div., American Monorail Co., has published a 44-page catalog, CDA, describing its "Cable-Way" overhead conveyor.

The catalog contains 10 pages of installation photos. Also illustrated are all of the components of the system. Information in the catalog is claimed to be complete enough to engineer a conveyor of any size. **—K-89**

PROTECT Your Machinery with THOMAS ALL METAL FLEXIBLE COUPLINGS



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They will protect your equipment and extend the life of your machines.

Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

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3. **Smooth Continuous Drive with Constant Rotational Velocity**
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WARREN, PENNSYLVANIA, U.S.A.

Make dust "taboo" ...in your plant!

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Norblo

Dust and Fume Collection

Much has been done about air pollution during the last 40 years, but a new wave of awareness to its widespread dangers finds government authorities, scientists and businessmen searching for more efficient, more complete methods of controlling dust, fumes, smoke, and odors.

Norblo's experience of nearly 50 years in the removal of injurious industrial air contaminants has been extensive in most industries. The three major types of collectors illustrated are recommended for the work each is best suited to perform. High recovery at low operating and maintenance costs is assured by Norblo's careful application check and guarantee of performance. All components of Norblo collecting systems are made in our own shops, including the exhaust fans.

Ask your consultant about Norblo — or write the factory for full information.

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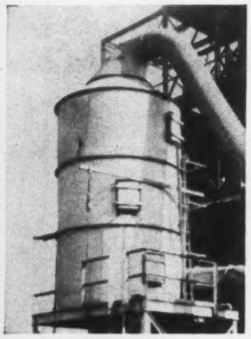
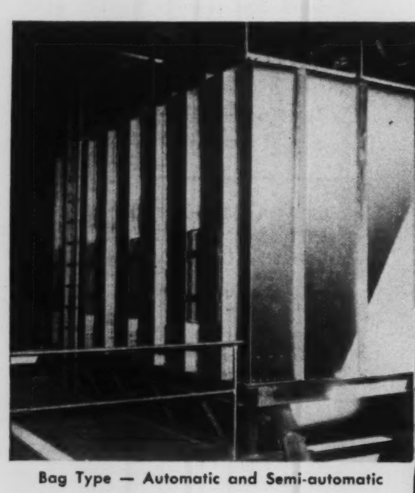
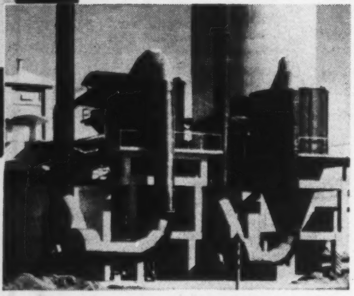


Hydraulic Type



Bag Type — Automatic and Semi-automatic



Centrifugal Type

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

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Gas Cylinders

Facts about high-pressure gas cylinders for oxygen and other industrial and medical gases are contained in a bulletin released by Pressed Steel Tank Co.

The range of cylinder sizes, capacities and ICC specifications are included along with data on the weight-saving value of seamless cold drawn cylinders. **—K-90**

Air Control Valves

A "Valve Finder", featuring discussion of air valves and their selection together with condensed catalog listings of all the firm's valves, has been announced by Hannifin Co.

The first section provides an explanation of valve terms and principles used in the air control valve industry. Included is a 3-step outline covering valve types, means of actuation and operating principles to simplify choosing the exact air control valve best suited for any application. The remainder of the 12-page booklet includes pictures, descriptions and catalog data on every air valve in the line. **—K-91**

Dust Collector

A 20-page product bulletin describing the Type D Roto-Clone dust collector has been released by American Air Filter Co.

The new bulletin provides product information about its application, principle, design, construction, operation, installation, and arrangements. Ten illustrated pages describe hoppers, precleaners, aftercleaners, including arrangements for trickle valve, dust doors, rotary locks, and dust gates. Charts and graphs give performance characteristics, capacity tables, shipping weights, pipe resistance and general air engineering data. **—K-92**

Control Switch

Construction features of Allis-Chalmers Type 210 instrument and control switches and their advantages are described in a new bulletin released by the company.

Available as either maintained or spring return contact types, the switches are used in conjunction with circuit breakers, transformer tap changers, motor-operated rheostats, instruments, and many other types of electrically controlled apparatus. Rated for 20 amp continuous capacity with 600 v insulation, the switches are designed for panel mounting and are furnished with a choice of handles. **—K-93**

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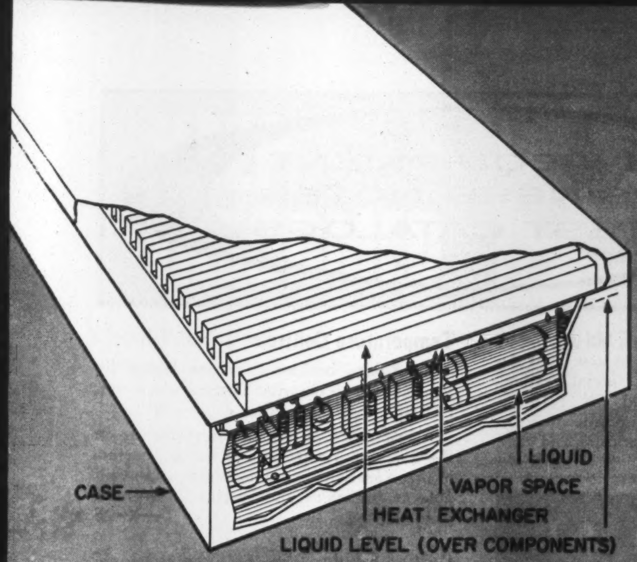
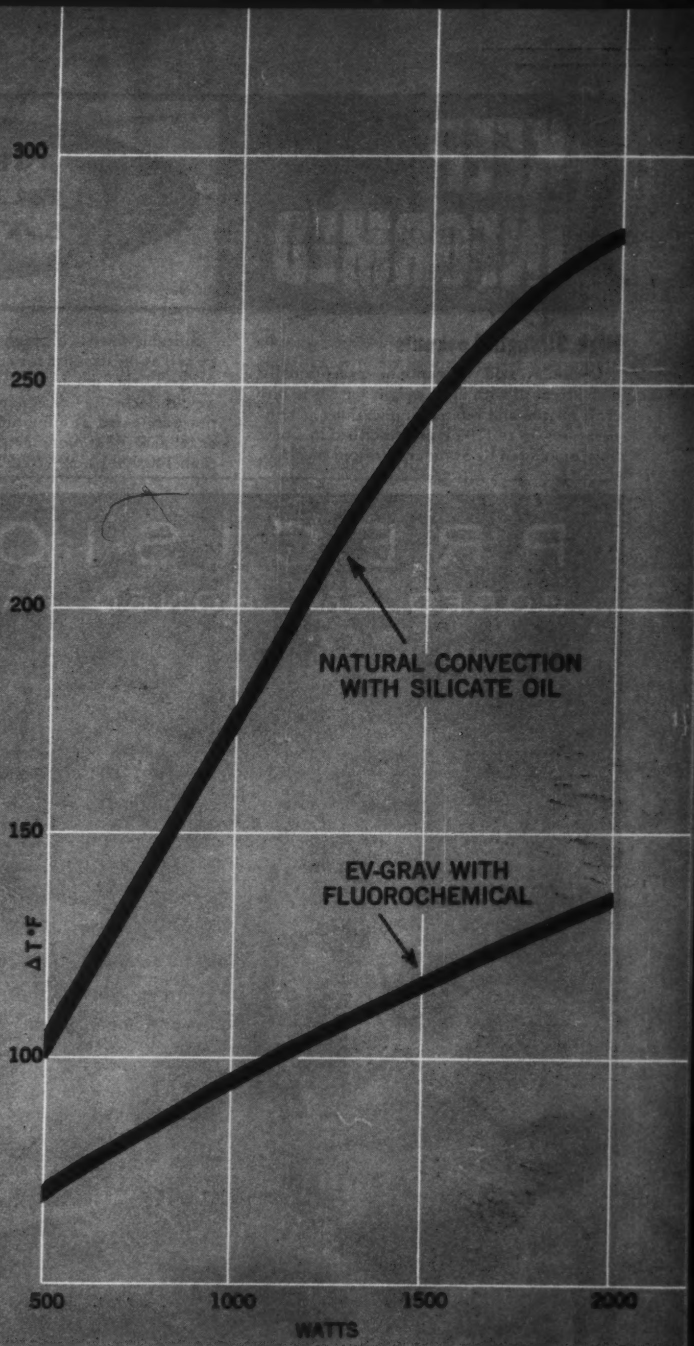


In Raytheon's "EV-GRAV" system, liquid refrigerant boils off the surfaces of the individual electronic components, rises as vapor, condenses on the heat exchanger, and drops as liquid to repeat the cycle.



"EV-GRAV" COOLING

IN THE DESIGN OF HIGH HEAT-DENSITY ELECTRONIC EQUIPMENT

Performance requirements for electronic equipment in supersonic aircraft and missiles place particular emphasis on the need for more efficient heat transfer techniques.

The use of fluorochemical refrigerants in an "evaporative-gravity" cooling system is a novel method of removing heat from electronic components. The refrigerant boils at the surfaces of submerged heat-dissipating components and condenses on the surface of a heat exchanger at the top of the package.

This technique has proved more efficient than free convection in oil dielectrics or forced convection with gas dielectrics. The high dielectric strength of the fluorochemicals permits the achievement of higher density packaging.

Contributions such as this are typical of the Heat Transfer Group in Raytheon's Government Equipment Division . . . assisting design engineers in developing the complex weapons systems of tomorrow.

PROFESSIONAL ASSOCIATION WITH A FUTURE

Qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments are invited to write Donald H. Sweet, Government Equipment Division, Raytheon Manufacturing Company, Wayland, Massachusetts.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *Waltham, North Dighton, Mass.*

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Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION

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High Strength Locknuts

Locknuts said to combine exceptionally high strength with light weight for use in aircraft missile and related applications at temperatures up to 1200 F are described in a new bulletin offered by Standard Pressed Steel Co.

Suitable for use on present MS 9033 bolts as well as on stronger fasteners now being developed, the one-piece, all metal featherweight locknuts—designated FN 1216 series—are rated at minimum tensile strengths of 160,000 psi at room temperature, and more than 140,000 psi at 1200F. **—K-94**

Temperature Controls

An 8-page booklet has been issued by Fenwal Inc. to describe Thermoswitch controls and mounting wells.

A description of how the units operate on the differential expansion of metals, operating specifications and dimensions, and available modifications and special features are included. **—K-95**

Cutting Fluids

A four-page folder on the evolution of a modern cutting fluid is available from E. F. Houghton & Co.

It describes the development of coolants from water to oil to fortified petroleum bases, then to heavy-duty water-soluble concentrates, and now to chemically conceived coolants containing no petroleum. Hocut 237 is the new product being featured for its long life, freedom from rancidity, rust protection and lubricity. **—K-96**

Motor-Operators

A motor-operator which can open, close or reset molded-case circuit breakers is described in a bulletin published by I-T-E Circuit Breaker Co.

The four-page bulletin illustrates and describes design, construction, and operating features of the new Telemand, a motor-driven electrically operated mechanism which provides for remote control of molded-case breakers. The new operator can be added to any ET molded-case breakers in ratings from 70 to 800 amp, incorporated in switchboards, control centers or individual enclosures. **—K-97**

Submersible Motor

General Electric Co. has issued Bulletin GEA-6853, six pages, describing design and performance features of the first oil-filled motor ever marketed as a complete unit for 4-in. well applications. The illustrated publication contains motor ratings and dimension chart with cutaway view of the motor. All mounting dimensions conform to NEMA standards for submersible water-pump motors. **—K-98**

Missile Systems

An eight page brochure on the firm's abilities and facilities in missile system development and precision production has been published by Ford Instrument Co.

The brochure illustrates and describes systems, subsystems and components for such missiles as the Jupiter, Jupiter C, Redstone, Tartar, and Terrier. It lists the company's current specialized projects in guidance and control systems, missile-borne subsystems, ground support equipment, producttion test equipment, and specialized components. **—K-99**

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Over 40 years ago we decided to make it our exclusive business to make parts with holes. Naturally, we have become deep boring experts and constantly seek the unusual in hollow bored parts. We have developed the wide range of specialized tooling that is required in our unique business and the special skills and machines to use them to save you time and money. Let's have your specifications for bored and honed parts.

Write for 20 page brochure describing American service.

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Clutch-Pulley Package

Warner Electric Brake & Clutch Co. offers a new Electro-Sheave brochure.

The 10-page booklet describes in detail the new clutch-pulley package for direct installation on standard electric motors from 1 to 25 hp. Included are sections on description, operation, dimensions, and selection. **—K-100**

Steel Surface Coating

Four new recommendation bulletins designed to help in preparing specifications for coating steel surfaces are available from Rust-Oleum Corp.

The bulletins cover coating galvanized iron surfaces, coating steel water tanks, coating metal window sash, and coating structural steel. **—K-101**

Fly Ash Handling

Low-cost fly ash handling methods using pneumatic conveyors are detailed in a 16-page bulletin offered by Fuller Co.

Designated FF-49-1, the two-color bulletin describes pneumatic systems used in fly ash handling, including the Airslide fluidizing conveyor, Fuller-Kinyon pumping system, and rotary compressor. Control panels, feeders, rotary bin discharge valves, material level indicators, and pipeline diverting valves are also described. The bulletin discusses typical installations in leading power companies and in a concrete block manufacturing process. **—K-102**

Pressure Regulator Pilot

A catalog sheet now available from Atlas Valve Co., describes Fig. 8000 super-sensitive pressure regulator pilot for regulating and reducing the pressure of steam, air, gases, and liquids within fractions of one pound in one stage.

The pilot uses 20 to 75 psi air or water pressure to actuate the control valve. It is used with single or double seat valves, $^1/_2$ to 12 in. inclusive and is easily modified to provide for reverse action. **—K-103**

Live Storage Racks

Lamson Corp. announces the release of a four-page bulletin showing a few of the gravity type racks available for live storage and order picking applications.

The booklet says that while gravity racks are usually custom designed to fulfill a requirement, the variations are generally only modifications of a few basic designs. Several illustrations have been included which demonstrate the applications of various racks to meet specific needs. **—K-104**

Submersible Pump

Bulletin No. 6700-2, recently released by Deming Co., presents the firm's new low-priced submersible pump.

The one-sheet bulletin covers the pump's features including flatted stainless steel shaft; lightweight Fianite diffusers; self-aligning, taper-locking spline shaft coupling; and three-wire cable with special waterproof connectors. Other features include motor characteristics, performance tables, special parts such as drain fittings, combination check valve and union, combination check and air intake valve, lightning arrester, and well caps. **—K-105**

WATER PRESSURE CONTROLLED

G-A *Cushioned* Water Pressure Reducing Valve

Like the elephant, water pressure can be big trouble if not controlled. That's what the Golden-Anderson Pressure Reducing Valve does. This sensitive valve always delivers water at the same predetermined pressure . . . regardless of upstream variance. No need to fear water line damage from high initial pressures with this Golden-Anderson Valve on the job.

Write for Bulletin W-3A

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Designers and Manufacturers of VALVES FOR AUTOMATION

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Pressure Gages

Kunkle Valve Company announces a catalog of pressure gages featuring a new completely safe safety gage case for all high pressure applications.

Safety features claimed for the new case include: a safety wrapped tube to smother any explosive action; a removable armor plate dial-backing to confine the explosive force; a solid back to give equal protection in areas back of the installation; blow-out plugs to prevent build-up of pressure within the gage case and safety glass lens. **—K-106**

High Vacuum Pumps

The firm's new SC series of small compound high vacuum pumps—in 2 and 3 cfm capacities—for laboratory and production applications where rapid pumping and an ultimate blankoff pressure of 0.1 μ are desired, is described in a new bulletin published by the Vacuum Equipment Div., F. J. Stokes Corp.

Specifications and pumping speed curves for the two initial models in the SC series are given, and the pumps' outstanding features are outlined. **—K-107**

Aluminum Machining

A reference handbook on machining of aluminum has been published by Reynolds Metals Co.

The 32-page booklet provides data on machining practices, tool angles and designs, and tool materials. Proper speeds, feeds, lubricants, and cutting compounds are explained. Eight charts, illustrated and supported by condensed text, cover eight major machining operations: turning, milling, shaping and planing, drilling, reaming, tapping, filing and sawing. The text also explains grinding operations. **—K-108**

Coil Dehumidifier

A 24-page catalog, Bulletin 9427, describing draw-through and blow-through sprayed coil dehumidifiers is now available from American-Standard, Industrial Div.

The new catalog has a complete section devoted to principles of blow-through sprayed coil dehumidifiers and application recommendations. Also included are illustrations and descriptions of construction details, optional arrangements and related equipment. Typical specifications, a recommended procedure for sizing the unit and a discussion of three humidification methods are included. **—K-109**

Diesel Engines

A 12-page illustrated brochure describing the selection of industrial and automotive engines now available in GM Diesel's new all-purpose power line has been released by Detroit Diesel Engine Div., General Motors Corp.

The booklet gives power ratings and overall dimensions on over 100 in-line, V and turbo-power engine models. It includes fan-to-flywheel and base-mounted power units to power or re-power practically any type of industrial, construction, petroleum or agricultural equipment. Truck engines listed include E models and the new V and in-line units introduced in January. **—K-110**

Continued on Page 181

low air pressure can
SABOTAGE
your plant production

Curtis protects... against it!

Air hammers, drills, sand blasts may be working... but are they working at peak efficiency?
With the right Curtis compressor on the job, you can be sure of an adequate and dependable supply of compressed air at the proper pressure.

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The sealed, precision-built Curtis AIR COMPRESSOR delivers all the power your tools can use.

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Tank-mounted compressors, ¼ thru 20 H.P. (1 to 95 cu. ft.).
Simple and base-mounted, ¼ thru 50 H.P. (1 to 217 cu. ft.).

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LIFT, LOWER ...
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UP TO 10 TONS

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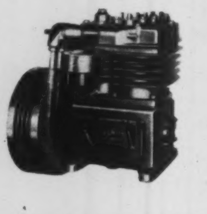

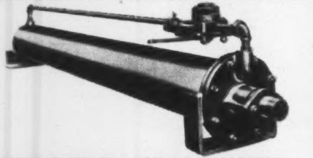

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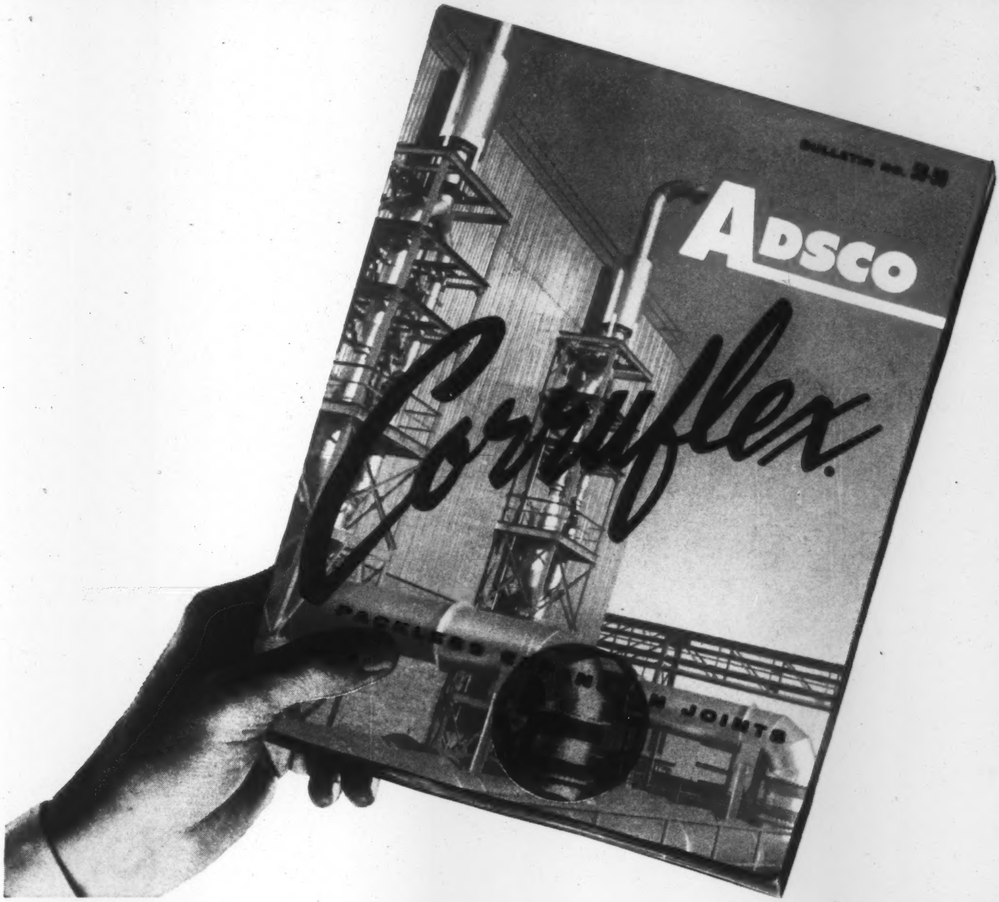
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Every engineer working with piping that requires precise control of movement of any type, will find this new 76 page booklet one of his most valuable working references. ADSCO Corruflex Packless Expansion Joints in a wide range of metals and alloys, for high and low pressures and temperatures, are fully described and illustrated, with complete engineering and installation data and comprehensive tables of forces, movements and dimensions. You can rely on ADSCO . . . world's largest manufacturer of both packless and slip-type expansion joints.

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The specially-processed fish oil vehicle in the Rust-Oleum 769 Damp-Proof Red Primer penetrates rust to bare metal—as proved in radioactive tracing studies.

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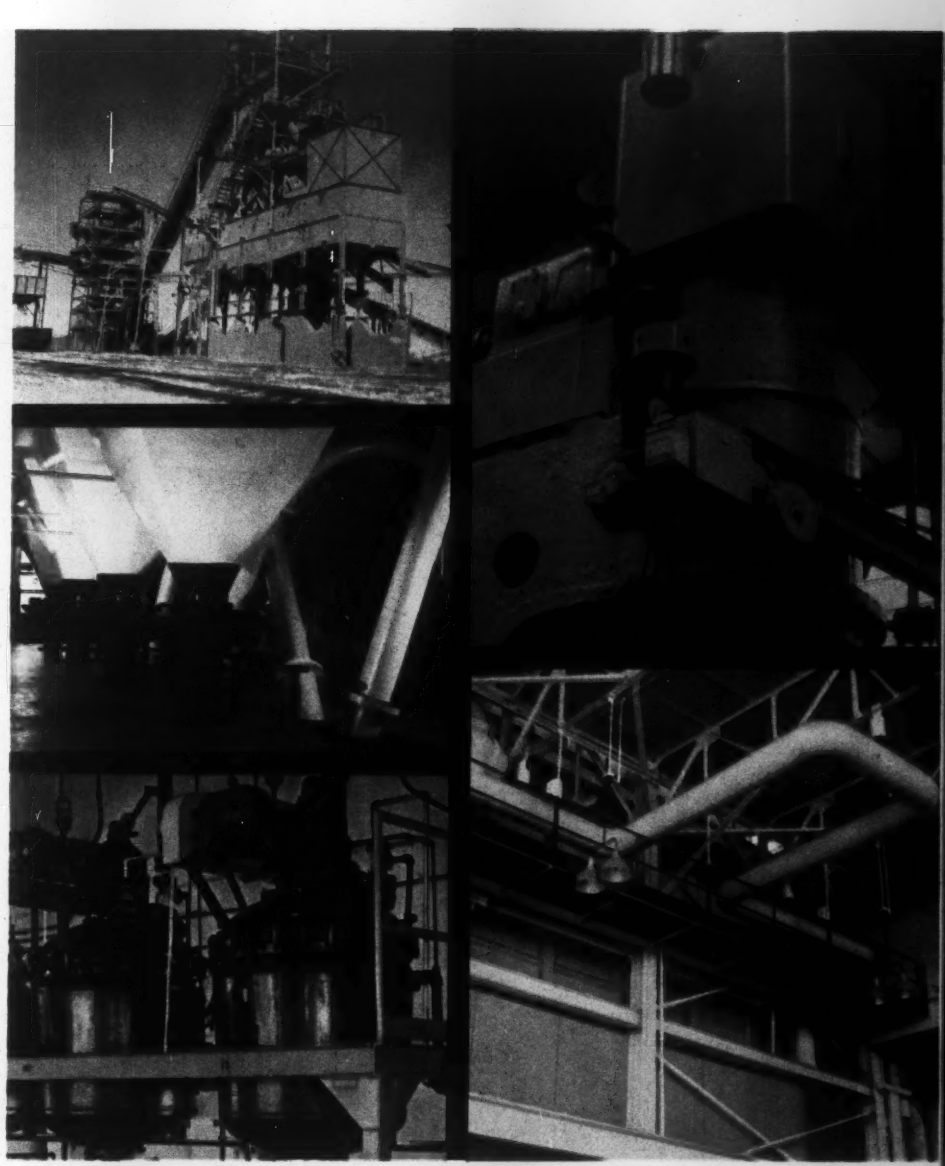

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- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer for rusted metal surfaces.
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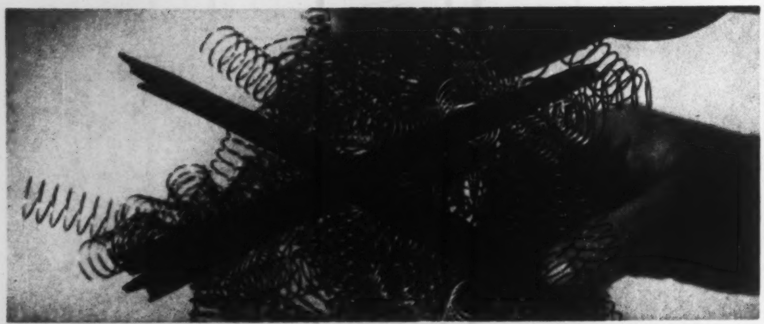

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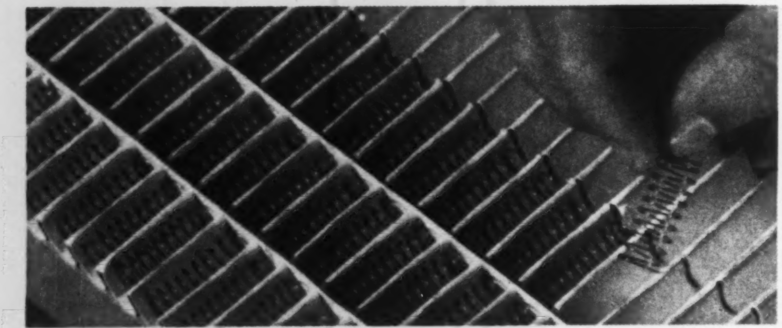

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Spring Flow brings springs, wire forms, and other fabricated-metal parts into your plant packaged for efficient production. No need to waste time untangling—no distortion. Shape and finish are protected in use or storage. Inspection and selection is easier, faster. Special packaging or dispensing speeds up hand or automatic assembly.

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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Continued from Page 176

Ground Flat Stock

Brown & Sharpe's new bulletin, No. M80, is a combination catalog and price list showing the availability of the company's line of precision ground tool steel and low carbon ground flat stock.

The 16-page bulletin describes characteristics and benefits of the firm's Ready Mark precision ground tool steel, pre-colored blue for oil hardening and maroon for air hardening, and available at no price premium over the cost of plain tool steel. **—K-111**

Instrumentation Recorder

An eight-page brochure describing the PS-200 magnetic tape instrumentation recorder is now available from Precision Instrument, Co.

The brochure outlines specifications and describes the instrument's transistorized electronics and unique magazine loading feature. Combining these features has enabled the manufacturer to produce a complete 7-channel recorder/reproducer that weighs 65 lb and requires only 250 w of power. Comparable existing equipment weighs 1000 lb and requires 1200 w of power. **—K-112**

Remote Weight Recording

The latest accomplishments in the field of transmitting and processing of weight data are described in an eight-page Toledo Scale brochure.

It is pointed out how the firm's new units bridge the gap between the accurate indication on the dial and the use of the weight data at accounting control points by automatic weight data transmission. Systems described and illustrated include those using the direct digital scanner which electronically transmits a continuous signal of weight being applied to the scale and also the direct digital selector which is an electromechanical device that sends an electrical signal when the scale indicator reaches the accurate weight indication. **—K-113**

Precision Pressure Gages

The firm's line of precision pressure instruments is described and illustrated in a 36-page booklet, Catalog DH-65, released by Helicoid Gage Div., American Chain & Cable Company, Inc.

The instruments can be utilized on equipment such as turbines, engines, blowers, locomotives, hydraulic presses, tractors, pumps, compressors. Engineering information, describing how the gages work, types of systems, adjustments, applications, dimensional drawings, specifications, accessories is given. **—K-114**

Diamond Grinding Wheels

A brochure on diamond wheels (both natural and man-made diamonds) for carbide grinding, dealing with bond types, infeed and table speeds, wet grinding, diamond concentration and types of wheels, is available from Carborundum Co. **—K-115**

Electro-Feedback Systems

An illustrated eight-page report on electro hydraulic pump strokers for versatile open-loop hydraulic circuitry has been published by Oilgear Co. **—K-116**

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INSTRUMENTATION...

DESIGN ENGINEERING...

PRECISION MANUFACTURE?

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We are specialists in the development and manufacture of custom optical-mechanical devices . . . concentrating on products which require high engineering excellence and precision manufacture.

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KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Oil-Free Compressors

A bulletin offering information on WGO-9 oil-free compressors has been published by Joy Mfg. Co.

The bulletin's 12 pages provide data on 14 sizes of the heavy duty industrial compressors ranging from 95.6 to 939 cfm. Included are part-designated section drawings, installation photos and a special section on the T-block design compression ring.

—K-117

Bearing Lubrication

Lubrication of miniature instrument bearings is the subject of a new lubrication manual recently issued by Miniature Precision Bearings, Inc.

The manual supplies data and information of the various types and brands of oils and greases available to bearing designers and users. It deals with subjects such as oil and grease lubrication, properties of lubricating oils and greases, military specifications, standards, and special lubricants. Blending charts, nomographs, and other data are also included. **—K-118**

Diaphragm Valves

A six-page bulletin on diaphragm valves has been released by Hills-McCanna Co.

The bulletin contains items to be considered when selecting valves for process piping systems. The advantages of diaphragm valves and their ability to meet pipe specifications is also covered. Typical process applications are shown. **—K-119**

Phosnic Bronze

Phosnic bronze, a high copper alloy that combines to an unusual degree high strength and high electrical and thermal conductivity is described in a booklet published by Chase Brass & Copper Co.

The booklet describes the various forms, tempers and properties of the alloy, as well as its composition and a number of typical uses. Also included are discussions of endurance strength, creep and relaxation resistance, stress-strain characteristics, electrical and thermal conductivity, corrosion resistance, workability and heat treatment.

—K-120

Aircraft Measurements

General Electric Co. announces Bulletin GEA-6788, 15 pages, containing specifications and ratings for new advanced design airborne a-c and d-c panel instruments with integral lighting capability, standard design airborne a-c and d-c panel instruments, aircraft instrument current transformers and ground maintenance equipment.

—K-121

Flexible Couplings

A six-page product bulletin describing standard and specially-engineered bonded rubber flexible couplings is available from Lord Mfg. Co.

Bulletin No. 205 contains specifications for three standard shear-type flexible couplings, $^{1}/_{50}$ to 100 hp at 1750 rpm. The formula for selecting the correct standard coupling for other speeds is given. Custom-engineered flexible couplings are illustrated in typical installations indicating the range of size and torque capacity already applied. Data for designing or choosing any coupling is listed.

—K-122

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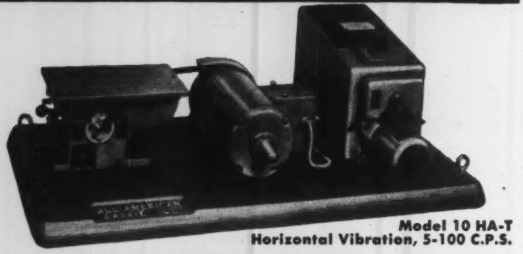
SPOT VIBRATION WEAK SPOTS
BEFORE COSTLY FAILURE!



Model 10 HA-T
Horizontal Vibration, 5-100 C.P.S.

• How much vibration will your product take? Where are the danger areas? All American Vibration Fatigue Testers answer these questions in your shop or laboratory with shake-down tests that simulate field service vibrations. Engineering gets the facts needed to improve design at lowest cost. Equally effective in spot-checking production runs.

• All American Testers meet U.S. Government specifications for horizontal or vertical vibration testing of all sizes and shapes of units weighing up to 150 lbs. Range Selector automatically controls acceleration and deceleration, or holds vibration frequency at any desired point between 5 and 100 cycles per second.

CATALOG "F"
gives full facts on all 10 All American Testers, proved in long service to government and industry.
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SPECIAL ELECTRIC VARIABLE SPEED HYDRAULIC TRANSMISSION

COST GOV'T $3500.00

An electric, reversible variable speed transmission. Use where remote or automatically controlled variable speed drive is needed. . . on Lathes, Band Saws, Conveyors, etc. As a Torque Amplifier it will operate a Boat Rudder, Robot Manipulators, etc. As a Servo Motor it will operate large Valves, Ventilators, etc. Each unit is complete with a variable displacement hydraulic pump and motor – both integrally mounted inside oil reservoir. Electric motor is 5/8 HP, 220 V, 60 cycle, 3-phase, 3425 RPM. Remote unit has an electric differential Selsyn motor. Lowest gear reduction is 24 to 1 giving tremendous torque through a 1" output shaft. Delivers 435 inch lbs. of torque at 50 RPM. Also available with a 3/4 HP, 3425 RPM, single phase electric motor at the same prices.

MANUAL CONTROL 138.88 REMOTE CONTROL 148.88

ELECTRIC HYD. MOTOR PUMP AS LOW AS $115

Motor designed to face mount any Aircraft type Hydraulic Pump. Made to meet the most rigid requirements of industry. For continuous duty with a high starting torque. Available in 115/230 V, 1 phase or 220/440 V, 3 phase – 60 cycle AC. Sizes from 3/4 to 15 HP. Pressures up to 3000 PSI. Write for Cat. H-59 for complete information and other Bargains.

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Precision built for Army Gun Control Mechanism. Gear ratio gives approx. 90 RPM with direct drive 1750 RPM motor. Can be belt driven with up to 1/2 HP motor. Has ball bearings throughout. Will operate conveyors, timing devices, etc. 21 to 1 gear ratio. 14.75
NOTE: Many other gear Bargains in stock. Write for Catalog Supplement H-59.

GRAVITY CONVEYOR

Has 500 lb. per ft. capacity. 12" wide curved steel frame with guard rail. 5 rows of 2" dia., 5/8" face ball bearing steel wheels. Unit is 45° ACR on 35" center line radius. Each unit couples to next at ends. Unused, excellent condition. 14.95 EA.

HYDRAULIC REMOTE CONTROL MASTER & SLAVE

When connected with 1/4" tubing these units act as a precision, remote power transmission unit. Moving master handle causes the slave arm to respond in exact ratio to the master. Ideal for remote machinery controls. Both units (used) No. H-EX-1SU 27.50

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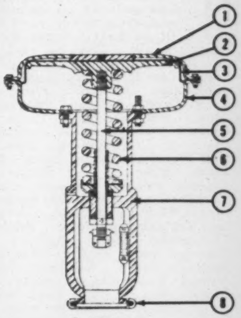
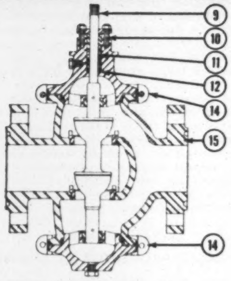
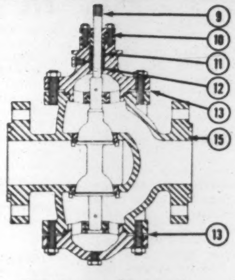


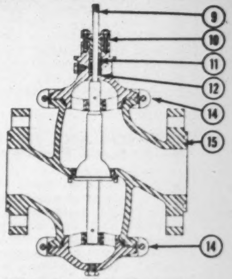
Actuator



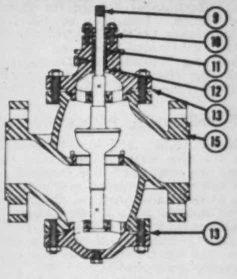
DP Body w/clamp ring—float ring closure



DP Body w/flanged-gasketed closure



SP Body w/clamp ring—float ring closure



SP Body w/flanged-gasketed closure

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1. Direct, Reverse and Pressure Balanced Actuator
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3. Moulded Diaphragm of Buna-N With Nylon Inserts
4. Pressed Carbon Steel Case
5. AISI 303 Stainless Steel Stem
6. Tempered Steel Spring, Precision Calibrated To Within ± 2%
7. Ductile Iron Yoke
8. 2-Piece Forged Steel Clamp Ring
9. Type 303 Stainless Steel Packing Follower
10. Heavy Duty Adjustable Bolted Construction
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13. Flanged-Gasketed Closure
14. Clamp Ring—Float Ring Closure
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PROCEEDINGS, 3rd U. S. NATIONAL CONGRESS OF APPLED MECHANICS

A Published 1958. $20.00 to members and nonmembers.—Within this 904-page volume are reports of important studies in the fields of dynamics, vibration, elastic waves, elasticity, elastic structures, plasticity, viscoelastic flow, fracture, fluid flow, aerodynamics, and heat transfer. There are also discussions of new concepts and methods, and a large amount of new data which will aid in generating new ideas and new approaches toward solving other problems of the applied mechanics field. The information was presented by 155 well-known engineers at the June 1958 congress.

MECHANICAL IMPEDANCE METHODS FOR MECHANICAL VIBRATIONS

B Published 1958. $5.50.—Shows how impedance methods apply to lumped and continuous systems of simple and moderate complexity, reviews measurement techniques, demonstrates the power of digital computers by comparing the calculated and measured characteristics of a highly symmetrical system of moderate complexity, gives measured values of typical structures of large size and high complexity, discusses the importance of the impedance in influencing shock and vibration spectra measured in field service, indicates how to apply impedance methods to the calculation of vibration insolator effectiveness, treats impedance of some disordered systems, and illustrates how impedance methods may be used to find the response to random excitation.

SHOCK AND VIBRATION INSTRUMENTATION

C Published 1956. $5.00.—This book provides a fund of useful information on recent advances and new concepts in the technology of shock and vibration. Among the subjects discussed are random vibration, effect of non-rigid structures on vibration isolation, hysteresis and slip damping, vibration and shock testing, design approaches and analog methods. CONTENTS: Evaluation of Mounts Isolating Nonrigid Machines from Nonrigid Foundations. Experimental Study of the Effects of Foundation Resilience on Vibration Isolating. Effect of Material and Slip Damping on Resonance Behavior. Shock and Vibration Environments. Mechanical Design for Random Vibration and Shock. Influence of Electrical and Motional Impedance on the Control and Performance of Some Vibration Machines. Shock Testing Machines and Procedures. Damaging Potential of Shock and Vibration. High Speed Computing Methods for Shock and Vibration Problems.

METALS ENGINEERING: PROCESSES

D Published 1958. $13.50.—Presents detailed data on the various processes by which metals are converted into finished products. For each of the manufacturing methods, there is a compilation of the basic physical characteristics to be considered and the general advantages and limitations usually encountered. Concise, parallel data concerning the suitability of various metals for each process, and the tolerances on size and surface finish obtainable are included.

METALS ENGINEERING: DESIGN

E Published 1953. $10.00.—This book discusses the essential properties which need to be evaluated by the design engineer in his selection of one material over another. Comprising 48 sections and written by 43 well-known authorities, it deals with the over-all problem of selection of material and takes up such specific items as high temperature considerations, plasticity, residual stresses, vibration, fatigue, shot peening, cold working, nitriding, flame strengthening, impact, corrosion, non-destructive testing, surface finish and mass production, and design theory and practice.

METALS PROPERTIES

F Published 1954. $11.00.—Provides, in convenient charts and tables, data on a broad range of metals in common industrial use—AISI steels, ASTM steels, cast copper alloys, aluminum alloys, tin, magnesium, etc. Tabulated under each of the more than 500 metals listed is such information as the chemical composition of the metal; its brittleness, heat treatment and other characteristics; its industrial uses; treatment temperatures for forging, annealing, quenching, etc.; such technological properties as recrystallization temperature and hot working temperature, and a great deal of other pertinent information to help the designer choose the proper metal for each part or product.

ENGINEERING TABLES

G Published 1956. $12.00.—A collection of tables often wanted by engineers but not commonly found in handbooks covering: Bar Stock and Shafting. Conversion Factors. Formulas for Stress and Strain. Properties of Sections and Cylinders. Bearings. Bearing Load Analysis. Spur Gears. Helical and Herringbone Gears. Bevel Gears. Worm Gears. Cylindrical Fits. Standard Tapers. Keys and Keyseating. Bolts. Counterbores. Screw Threads. Slots. Serrations and Splines. Nuts. Pins. Snaprings. Washers. Wrench Openings. Springs. Aircraft and Mechanical Tubing. Pressure Tubes. Pipe. Pipe Threads and Fittings. Electric Motors. Graphical Symbols. Welding. Gaskets. Hydraulic Standards and Symbols. O-Rings. Packings. Seals. Bibliography.

POWER REACTORS (*Volume I of Nuclear Reactor Plant Data*)

H Published 1959. $3.75.—This second edition includes all known power-reactor and prototype power reactor projects designed and built as heat sources for the production of electric power. Data for each plant are tabulated on a standard form and include as many of the following details as were available up to the time of publication. **General.** Plant and Location. Reactor Type. Nominal Megawatt Rating of Reactor. Net Electrical Plant Output. Sponsor, Operator, Designers, Constructors. Present Status. Start of Construction. Reactor Critical Date. Full Power Operation Date. Plant Costs. **Power Data:** Reactor Heat Output. Net and Gross Electric Power. Turbogenerator Rating. Steam Turbine Conditions. Net Plant Thermal Efficiency. Steam Flow to Turbine. Total Steam Generated. Gas Turbine Conditions. **Nuclear Data:** Average Conversion Ratio. Specific Power, Average. Thermal and Fast Flux (Average and Maximum). Average Temp. Coefficient at Operating Temp. Excess Reactivity Available. Average Critical Mass. Weight % of Each Isotope in Fuel Material. Expected Time Between Plant Shutdown for Refueling at % Plant Load Factor. **Fuel Element and Blanket Description. Reactor:** Core Overall Dimensions. Core Configuration. Reactor Vessel. Number of Coolant Passes and Average Velocity in Each Pass. Moderator. Reflector. Shielding. Method of Refueling. Core Heat Flux. Average Fuel to Coolant Heat Transfer Coefficient. Method of Decay Heat Removal. Overall Hot Channel Factors Used in Core Design. **Reactor Control:** Type, Description and Scram Provision. **Primary** Coolant System. **Secondary** Coolant System. **Steam System.**

RESEARCH AND TEST REACTORS (*Volume II of Nuclear Reactor Plant Data*)

I Published 1959. $7.50.—Here will be found the latest available information on the types, sizes, purposes, and facilities of fifty-three research and test reactors located in the United States, and forty-two reactors situated in Canada, South America, Western Europe, Asia, and Australia. Data on each reactor are presented on a separate form, and include the following details: **General:** Location and Type. Operator. Cost of Reactor Facility. Operating Staff. Annual Operating Cost. Status. Design Power. Normal Operating Power, Power Density, and Specific. Power. Operating Schedule. Principal Use of Reactor. To Whom Available for Research? **Fuel:** Normal Fresh Fuel Loading. Total Fuel Inventory. Expected Average Burnup Before Reprocessing. Fluid Fuel. Solid Fuel. Method of Refueling. **Reactor:** Over-All Active Core Dimensions. Core-Containing Vessel Dimensions, Materials and Mean Operating Pressure and Temperature. Moderator. Reflector. Thermal Shield-Biological Shield. Reactor Control. **Primary. Coolant:** Fluid. Circulation. Heat Dissipation Method. Average Core Heat Flux. Ratio of Maximum to Average Heat Flux. Means of Purification. **Nuclear Data:** Fuel Loading. Fluxes. Reactivity Coefficients. Burnable Poisons. **Research Facilities.**

GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY (ASA N1-1)

J Published 1957. $5.00.—This 188-page American Standard contains the precise definitions of 1500 technical terms used in the nuclear field, as well as tables, charts and formulae considered useful. The terms included are those coined expressly for the nuclear energy field, those borrowed from other fields and employed here with a different meaning, and those used elsewhere, but which may be unfamilar to nuclear engineers. In short, this first standard dictionary of the nuclear energy field provides a common language among engineers, physicists, chemists, biologists, medical men, and others working with the atom.

ADVANCES IN NUCLEAR_ENGINEERING (2 VOLUMES)

K Published 1957. $35.00.—Volume I contains sixty-two contributions concerned with the manufacture, production, recovery, and economics of nuclear fuels; spent fuel processing; plant containment concepts and design; plant components; waste disposal; protection and safety measures; and radiation processing. It also includes a resumé of the international outlook for atomic power. Volume II has seventy-three articles dealing with reactor design; reactor core design; operation and maintenance of reactors; metallurgy; heat transfer and heat evolution; educational uses of reactors; and standardization planning in the nuclear field. Each volume has a subject and authors' indexes. The 130-odd paper in these volumes were presented at the 2nd Nuclear Engineering and Science Conference, sponsored by the 1957 Nuclear Congress.

HOT LABORATORY OPERATION AND EQUIPMENT

L Published 1957. $17.50.—Here is the rich fund of information on the design and construction of hot laboratory facilities; the equipment for hot chemical, physical, mechanical, and metallurgical operations; operation and administration of hot laboratories, hot cell installations; and specialized hot operations. Author and subject index included. These contributions were given at the 5th Hot Laboratories and Equipment Conference, also sponsored by the 1957 Nuclear Congress.

THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASES, LIQUIDS AND SOLIDS

M Published1959. $12.50.—Provides a wealth of information that can be profitably applied to the solution of many problems in various areas demanding a knowledge of thermal properties of materials. Specifically, the book surveys the present theoretical and experimental state of the science; reports a large amount of data on experimental and theoretical techniques; reviews and evaluates the present state of knowledge in the specific areas covered; and indicates the gaps of knowledge existing in both transport and thermodynamic properties, particularly at high temperatures and at high or even moderate pressures. The information was originally presented at a Symposium sponsored by the Standing Committee on Thermophysical Properties of the ASME Heat Transfer Division in February, 1959.

THERMODYNAMIC PROPERTIES OF COMPRESSED WATER

N Published 1957. $2.50.—Here is a chart that fills the need for an accurate and convenient presentation of the thermodynamic properties of compressed water. These properties which include temperature, pressure, specific volume, enthalpy and entropy, are presented graphically in a large scale chart broken up into fifteen plates. The temperature range covered is from 32 to 705.4°F and the pressure range, from 0.08854 to 6000 PSIA.

VISCOSITY OF LUBRICANTS UNDER PRESSURE

O Published 1954. $3.00.—This publication reviews and coordinates twelve experimental investigations, made over a period of thirty-five years, on 148 lubricants comprising of 25 fatty oils, 94 petroleum oils, 17 compounded oils and 12 other lubricants. Data are coordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Computation of the temperature coefficients of viscosity and the method of computing pressure coefficients are also given.

PROCEEDINGS OF THE CONFERENCE ON LUBRICATION AND WEAR

P Published 1958. $23.00—Here is the complete record of the 1957 Conference arranged by the Institution of Mechanical Engineers with the collaboration of the ASME for the purpose of evaluating current lubrication knowledge, bringing out the findings of important experiments conducted in the United States, Canada, United Kingdom, and Europe; and obtaining the views of those participating in the discussion. Subjects dealt with include hydrodynamic lubrication, boundary friction, boundary lubrication, bearing metals, novel bearing materials, glands and seals, solid lubricants, surface treatments, ball and roller bearings, gear lubrication, engine lubrication, miscellaneous lubricants and applications, additives, and wear. The 34 papers on the latter subject cover laws of wear rate; mechanism of wear; testing of materials for resistance to wear; surface films; effective temperature and environment; wear due to abrasion, fretting, scuffing, pitting; wear on cutting tools; wear in engines, gears, etc.; influence and nature of rubbing surfaces.

MATERIALS HANDLING HANDBOOK

Q Published 1958. $20.00. — With this Handbook you have the means for analyzing your own materials handling operations, planning for greater efficiency, installing and operating important systems, and measuring results. Illustrations, tables, cost, and work flow forms put best current practice at your finger tips. CONTENTS. Definition and Scope of Materials Handling • Analyzing Materials Handling Problems • Materials Handling Factors • Factory Planning • Materials Positioning in Production • Materials Handling Research • Materials Handling and Production Control • Communicating Systems • Training Personnel • Handling Bulk Materials • In-Process Handling of Bulk Materials • Unit Handling for Various Shapes • Unit Handling in Manufacturing • Scrap Classification and Handling • Uses of Containers in Industry • Industrial Packaging • Palletization • Warehousing and Yard Handling • Truck Terminal Handling • Railroad Terminal Handling • Marine Terminal Handling • Air Terminal Handling • Belt Conveyors • Elevating Conveyors • Chain Conveyors • Trolley Conveyors • Cable Conveyors • Haulage Conveyors • Vibrating and Oscillating Conveyors • Pneumatic Conveyors • Package Conveyors • Fixed Cranes, Derricks, and Cableways • Traveling Cranes and Towers • Portable Cranes • Elevators • Winches • Auxiliary Crane Equipment • Positioning Equipment • Powered Industrial Trucks • Industrial Hand Trucks • Industrial Tractors • Highway Trucks and Truck-Trailers • Railroad Freight Cars • Marine Carriers • Air Carriers • Containers.

ADVANCES IN MATERIALS HANDLING (*Being the Proceedings of the 1958 Conference of the ASME Materials Handling Division*)

R Published 1958. $4.50.—The subject coverage ranges from materials handling on the management level to new developments in pneumatic materials handling and in industrial bulk handling, the application of advanced materials handling techniques to non-mass production plants, the design and development of special equipment such as used for high capacity bulk handling and handling nuclear materials, handling problems with radioactive materials, materials handling equipment in missile launching, and materials handling in logistics for missiles.

DIAPHRAGM CHARACTERISTICS, DESIGN AND TERMINOLOGY

S Published 1958. $3.75.—This Manual defines a diaphragm and its performance characteristics, describes methods of measuring and representing them, shows how they are related and used, describes and illustrates the effects of design details and manufacturing methods on the characteristics. In the appendixes, the terms and notation used are defined, the equipment and methods of testing described, applications of the diaphragms classified and equations given.

FREQUENCY RESPONSE

T Published 1956. $7.50.—Design technique based on frequency response is now a prime analytical tool in numerous branches of modern techniques. Frequency Response offers an unparalleled amount of information on this tool. Covering the entire field from basic theory to experimental techniques, this book orients the reader in regard to historical developments, fundamental theory, and significant advances; describes frequency response aids such as types of sine wave generators for obtaining data, slide rules and nomographs for facilitating computation; discusses and illustrates the application of experimental methods of frequency response to process controls, servomechanism design and power systems; covers process control behavior, transient response, optimum control, nonlinear techniques, sampling controls and statistical approach to servomechanisms and regulators.

PROCEEDINGS OF THE 1955 JOINT CONFERENCE ON COMBUSTION

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FLUID METERS, THEIR THEORY AND APPLICATION

V Published 1959. $8.00.—This Fifth Edition includes information on a number of new types of fluid meters and metering procedures that have been developed in recent years. It is divided into three sections with the first giving the classification and nomenclature of fluid meters, together with definitions of special terms and other general information. The theory of fluid measurement and the steps taken to develop practical working equations from the theoretical relations are set forth in the second section. Figures and tables for use in solving practical fluid measurement problems, along with examples illustrating their proper use, are contained in the third section.

FLOW MEASUREMENTS (*Chapter 4, Part of 5 Instruments and Apparatus*)

W Published 1959. $5.00.—These rules apply when the primary element is an orifice, a flow nozzle, or a Venturi tube. The fluid may be compressible or incompressible. The primary element may be installed within a continuous section of pipe flowing full, or at the inlet or exit of a plenum chamber. Specifically this Chapter includes information on the construction of these three primary elements, the recommended techniques governing tests, the necessary equations for computing rate of flow, examples to illustrate the application of typical data, a discussion of tolerances applicable to certain of the factors involved in the measurements, and an outline of the major advantages and disadvantages of various types of primary elements.

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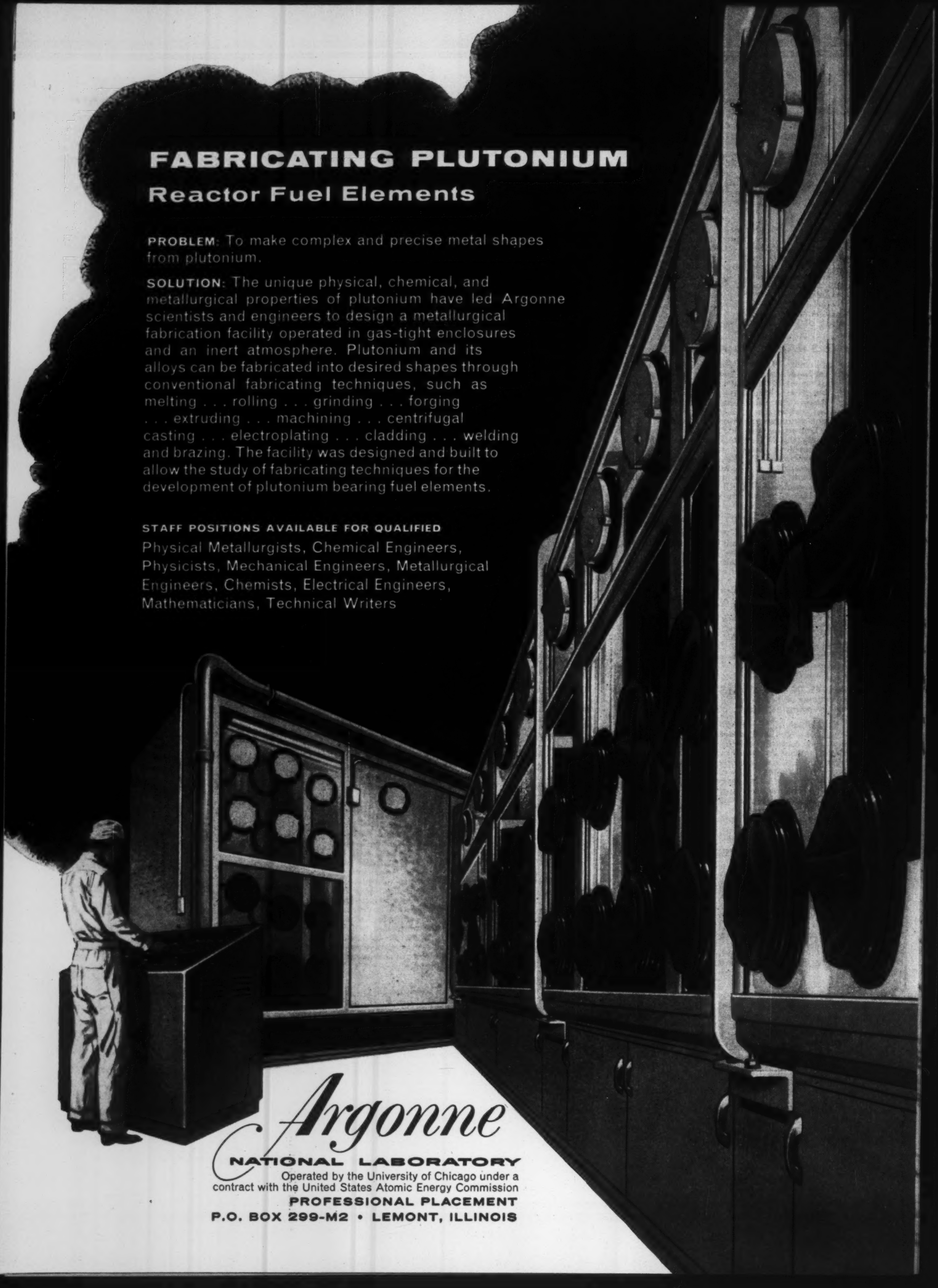

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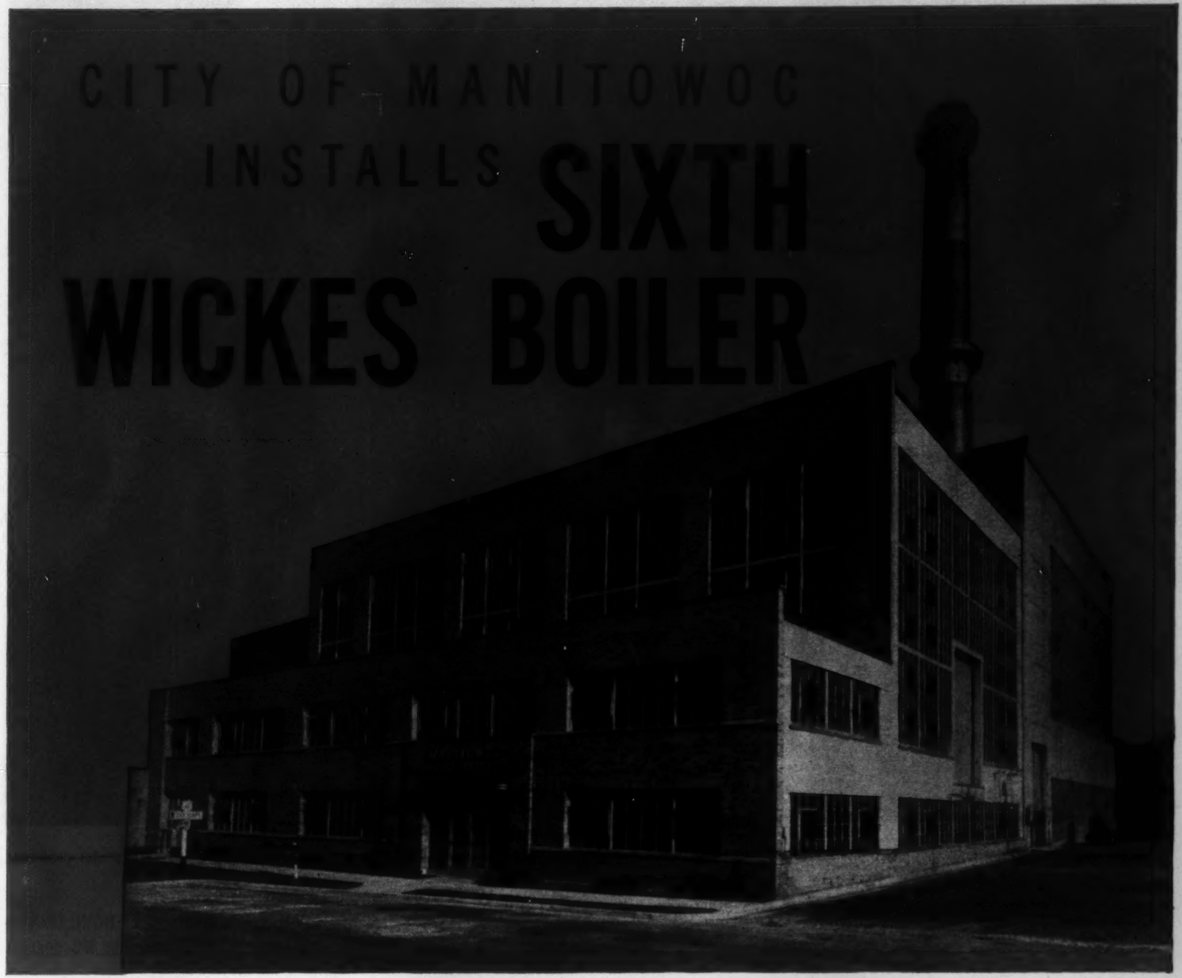

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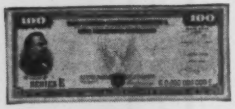

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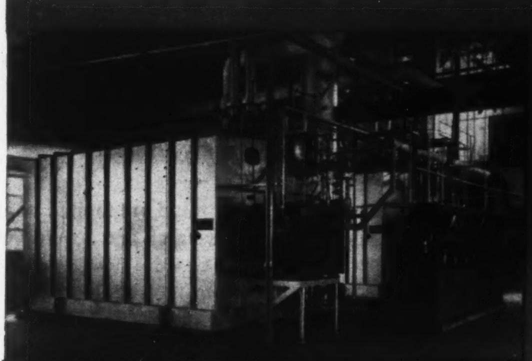

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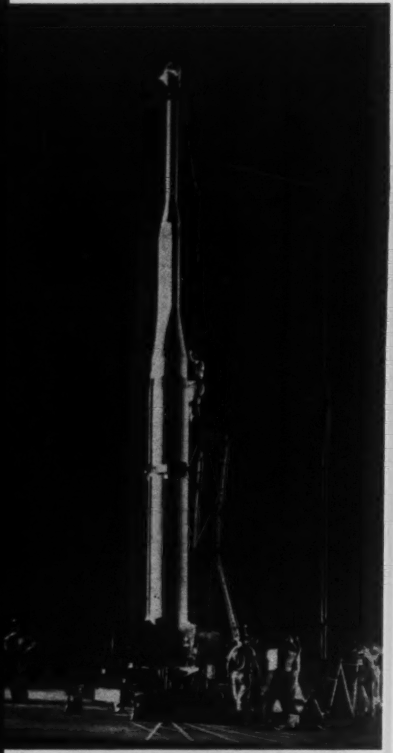

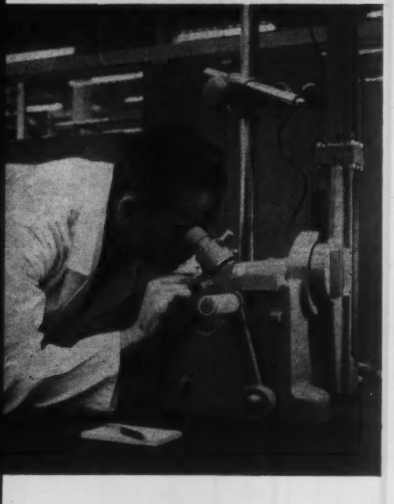

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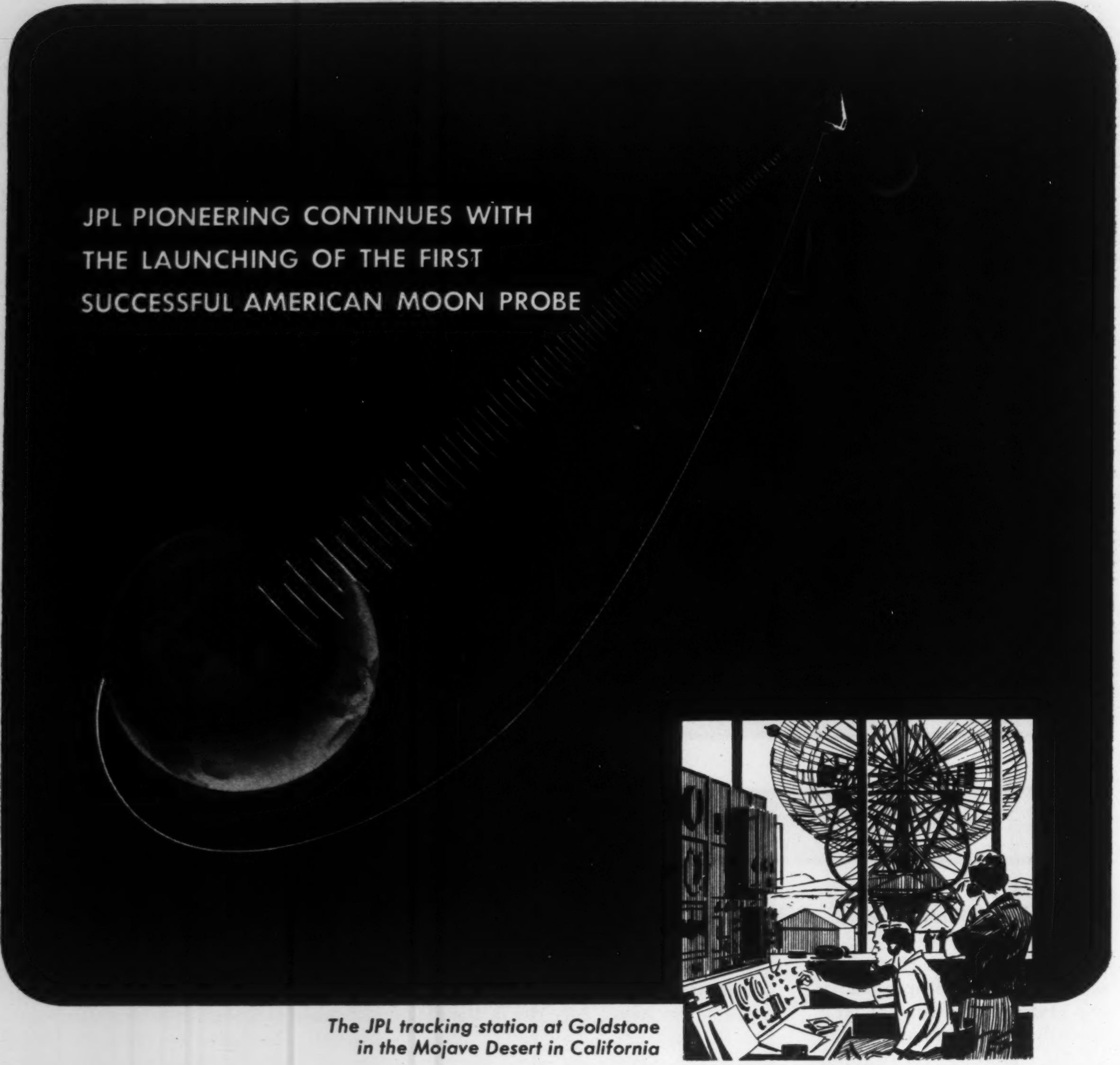

The JPL tracking station at Goldstone in the Mojave Desert in California

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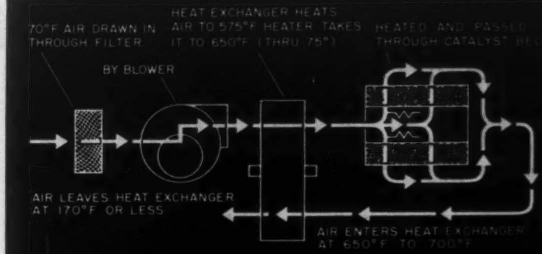
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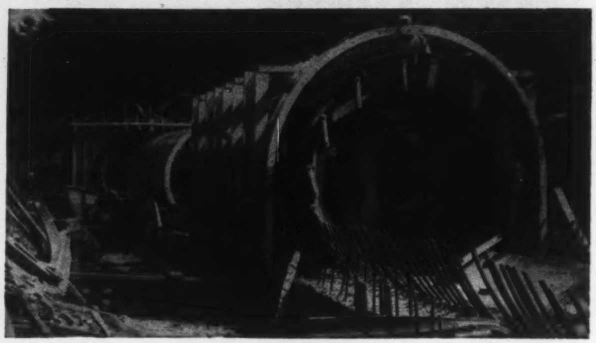

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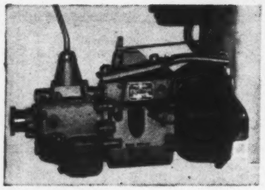


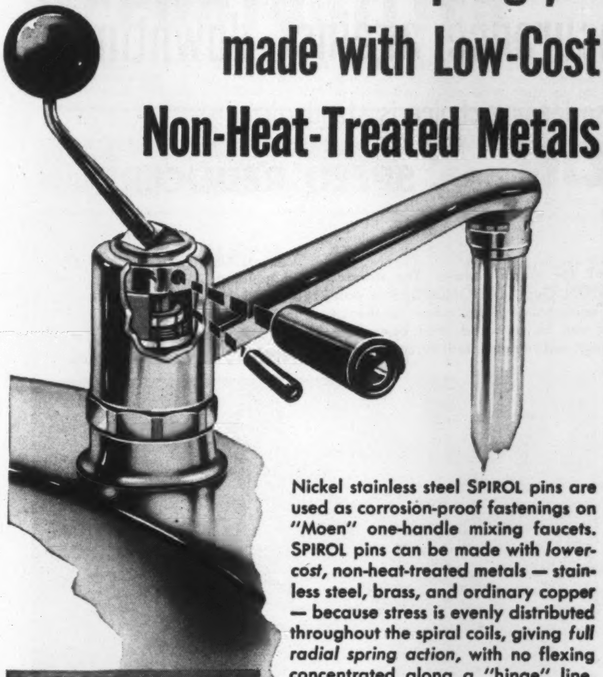
On this Rosco Road Roller, a FUNK-designed Revers-O-Matic Drive permits triple operation with just one foot lever. Instantly and smoothly changes the speed and direction of travel — without wheel spinning, provides neutral speed control and leaves hands free for other operations.

Just one example of how FUNK MODULAR POWER UNITS may be combined in an unlimited number of arrangements — without special engineering costs.

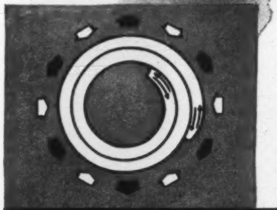
Let FUNK help solve your power transmission problem.

FUNK MFG. CO. Box 577-E
Coffeyville,
Kansas

SPIROL - the spring pin made with Low-Cost Non-Heat-Treated Metals

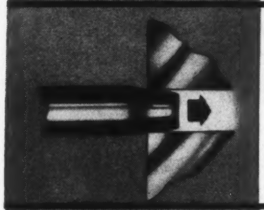


Nickel stainless steel SPIROL pins are used as corrosion-proof fastenings on "Moen" one-handle mixing faucets. SPIROL pins can be made with *lower-cost*, non-heat-treated metals — stainless steel, brass, and ordinary copper — because stress is evenly distributed throughout the spiral coils, giving *full radial spring action*, with no flexing concentrated along a "hinge" line.



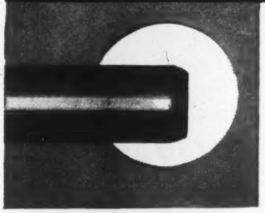
SHOCK RESISTANCE

High resistance to shock and vibration permits use of "medium duty" SPIROL pins in the majority of applications. Heavy and light duty SPIROL pins also available in stock.



WIDER HOLE TOLERANCES

Both plus *and* minus hole tolerances are allowed because spiral construction permits greater flexibility in expansion and compression. The wider hole tolerances eliminate precision reaming requirements, reduce drilling rejects, cut costs.



PERFECT CHAMFER

A. Smoothly rounded radius where chamfer meets shank eases insertion into hole. No sharp break to "bite" and resist insertion. *B.* Chamfer angle is precisely designed to offer minimum thrust resistance and maximum compression leverage.

MINIATURE PINS — SPIROL is the only spring type pin available in these miniature diameters: 1/32" — .039" — 3/64" — .052". Unique spiral cross-section retains flexibility and strength in smallest sizes. Other standard sizes up to ½" diameter.

FREE! *Write for literature on Spirol Pins.*

® SPIROL *the true spring* **PIN**

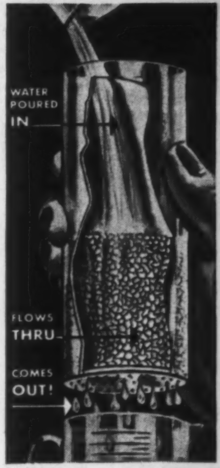
C.E.M. COMPANY • 132 SCHOOL ST., DANIELSON, CONN.

ZONOLITE®

Announces

A NEW KIND OF INSULATION

FOR MASONRY WALLS!



HERE'S PROOF! Simple test reveals how new Zonolite repels water penetration.

Cuts heat loss up to 50% in block & cavity walls

A triumph of technical research, revolutionary Zonolite Masonry Fill Insulation provides a completely new, remarkably effective way to insulate concrete block, tile and other cavity-type walls. Walls filled with this unique material have up to twice the insulating value. Cuts heating costs as much as 50%, air conditioning and refrigerating costs up to 25%. Unit size of heating and cooling equipment can be sharply reduced. Comfort of occupants is greatly increased...uniform heat distribution more easily accomplished.

Actually SHEDS WATER

Zonolite
MASONRY FILL

Moisture has no effect on the insulating value of Zonolite Masonry Fill Insulation. An exclusive process covered by U.S. Patent 2,824,022 makes it water repellent...keeps walls dryer.

Saves time...money

Zonolite Masonry Fill Insulation is inexpensive, installation cost is low. Poured into cavity, it flows freely, fills completely...no uninsulated voids...no measuring, cutting, or fitting. As much as 60% lower in cost than any other insulation. But why not get all the facts and see how you can best apply the advantages of this new insulation.

MAIL COUPON FOR FULL DETAILS

ZONOLITE COMPANY, Dept. ME-59
135 South La Salle St., Chicago 3, Illinois

Please send complete data file G158 on Zonolite Masonry Fill Insulation. I am interested in types of buildings checked.

☐ Schools ☐ Commercial Buildings
☐ Industrial Buildings ☐ Cold Storage Plants

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Firm____________

Address____________

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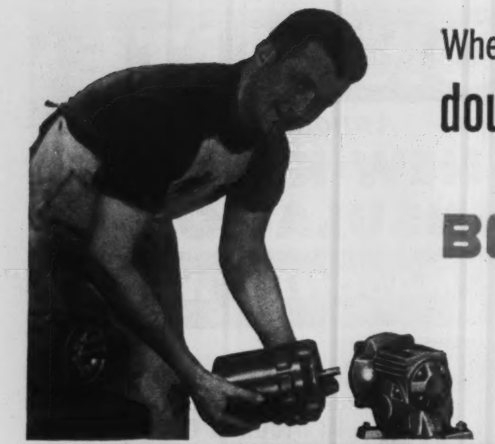
Where continuous automatic operations demand

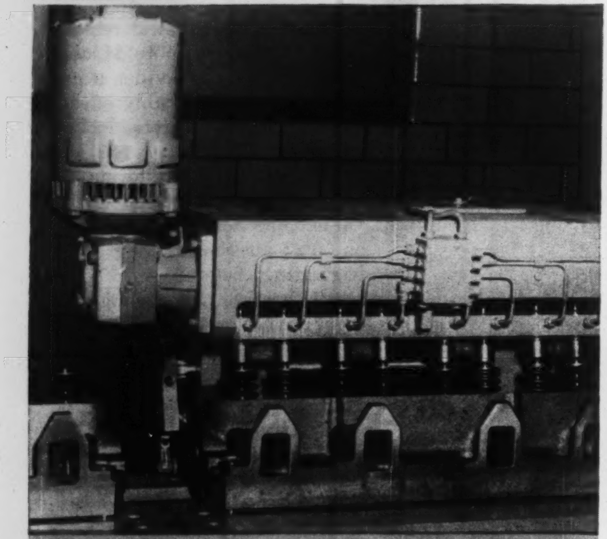
double insurance against downtime

the leading choice is standardized

BOSTON Gear® SPEED REDUCERS



NO DOWNTIME for motor repairs. The standard end-mounted motor on BOSTON Gear RATIOMOTORS is easily detached by removing the bolts holding the motor to the gear unit flange. A spare motor can be attached, and operations resumed in a *few minutes*. Gear unit remains undisturbed, preserving alignment.



BOSTON Gear Vertical Right Angle RATIOMOTOR drives the valve "popping" (final test) unit in a giant 29-station transfer machine for continuous automatic assembly of cylinder heads.

BOSTON Gear Horizontal Right Angle RATIOMOTORS drive magnetic belts which convey parts from lower storage bins to vibratory hoppers at start of 13-station, automatic assembly of roller skate wheels.

BOSTON Gear RATIOMOTORS are the leading choice for all types of installations where downtime would be disastrous to production schedules. One reason is BOSTON Gear quality standards, which assure highest efficiency and extra service life of the gear unit. Another is BOSTON Gear design leadership like the detachable motor which permits continued operation with a spare, avoids downtime. Design around BOSTON Gear RATIOMOTORS for this *double* insurance against downtime. All types and ratios are *standardized stock* models, quickly available anywhere from over 100 BOSTON Gear Distributors. Boston Gear Works, 66 Hayward Street, Quincy 71, Massachusetts.

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FROM STOCK!
AT YOUR NEARBY BOSTON Gear DISTRIBUTOR
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For nearest Distributor
LOOK UNDER "GEARS"
in the
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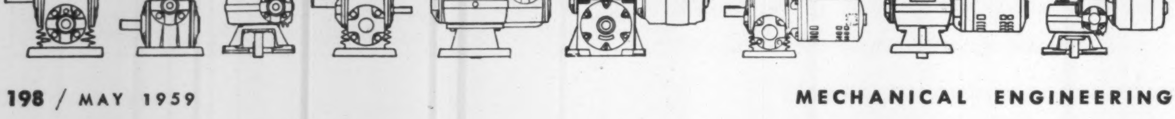
POWER TRANSMISSION PRODUCTS

REDUCTORS — RATIOMOTORS — FLANGED REDUCTORS — Catalog lists 1605 types and ratios



OPPORTUNITIES

positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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Engineers

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Perform mechanical design & test of tubes, components and tooling. 5 years' experience in mechanical design, testing & evaluating special purpose tubes.

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Please send resume to
Mr. Wayne Pearson

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On the San Francisco Bay peninsula

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mechanical engineers

The Chemstrand Corporation—manufacturer of Chemstrand® nylon and Acrilan® Acrylic fiber—has an immediate opening for a mechanical engineer interested and experienced in machine design or gadgeteering. Work and association with our Research organization will provide an opportunity for the use of imagination, originality and creative thinking in the design of laboratory equipment.

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If you have a B.S. degree in Mechanical Engineering with 2-5 years' experience in Mechanical Engineering or Machine Design, send resume of education and experience to:

Technical Personnel Manager
Box R 4
The Chemstrand Corporation
Decatur, Alabama

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Graduate Engineer with at least 10 years' experience in design of fabricated metal products; to head development section in Company engaged in production of railroad equipment and other industrial metal products. Will develop new and improved equipment for transportation of bulk products by rail and a variety of new products in line with diversification program. Must be able to locate in Chicago. Please send resume stating salary desired. All replies held in confidence.

Address CA-6679, care of "Mechanical Engineering."

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. . . With A Growth Company

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ME's or IE's with 3 to 5 years of Time Study and standards experience.

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EE or ME with some QC experience and supervisory background in electro-mechanical equipment.

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ME's with 3 to 5 years' process engineering experience in photographic or allied fields desirable.

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ME's with 3 to 8 years' experience in development of engineering standards and/or product engineering.

ME's with 2 to 6 years' production engineering experience in electromechanical equipment field.

Kindly send resume and salary requirements to:

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Industrial Relations Division

HALOID XEROX INC.
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READ the* CLASSIFIED ADVERTISEMENTS *appearing in this section each month.

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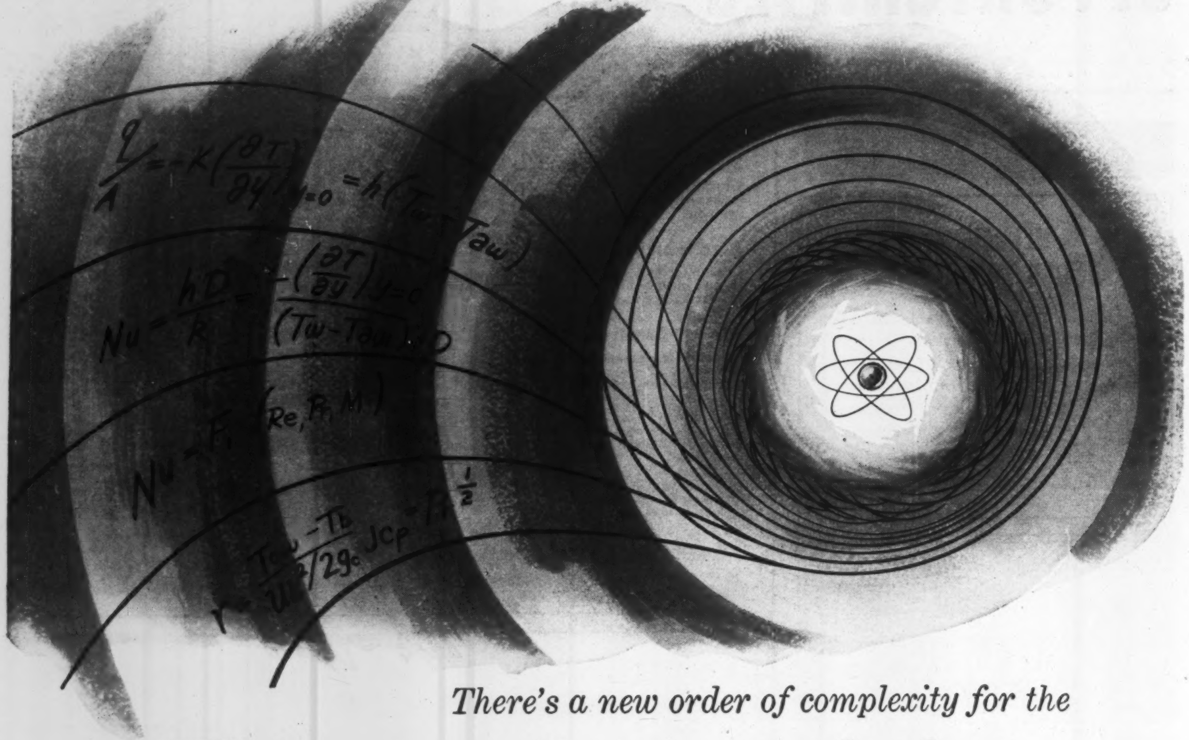
with ME, ChE or Nuclear Engineering Degrees (BS, MS)


$\frac{q}{A} = -k\left(\frac{\partial T}{\partial y}\right)_{y=0} = h(T_w - T_{aw})$
$Nu = \frac{hD}{k} = \frac{-\left(\frac{\partial T}{\partial y}\right)_{y=0}}{(T_w - T_{aw})}$
$Nu = F_1(Re, Pr, M)$
$r = \frac{T_{aw} - T_b}{U^2/2g_c\,Jc_p} = Pr^{\frac{1}{2}}$

There's a new order of complexity for the

Thermodynamicist

in developing the nuclear propulsion system for aircraft

The requirements for small-size, coupled with high-power density in a reactor for flight propulsion, raise problems in heat transfer never faced before.

As an indication of the technical difficulty of these problems, consider the fact that the reactor now being developed by General Electric for flight propulsion must generate more power than a submarine reactor, though it is only a fraction of the size.

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- HEAT TRANSFER AND FLUID FLOW DESIGN CALCULATIONS FOR NUCLEAR REACTORS.
- CALCULATIONS ON NUCLEAR DESIGN PARAMETERS OF EXISTING OR PROPOSED REACTOR COMPONENTS AS BASIS FOR CRITICAL EVALUATION.
- DEVELOPMENT TESTING OF HEAT TRANSFER & FLUID FLOW DESIGN OF REACTOR COMPONENTS.
- DEVELOPMENT TESTING OF REACTOR CORE COMPONENTS.
- MECHANICAL DEVELOPMENT OF POWER PLANT COMPONENTS. ALSO OF REACTOR STRUCTURAL COMPONENTS. *(Includes devising and conducting laboratory tests.)*

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Assignments are at several levels

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Write in confidence, including salary requirement.
Mr. P. W. Christos, Div. 41-ME
AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

GENERAL ELECTRIC

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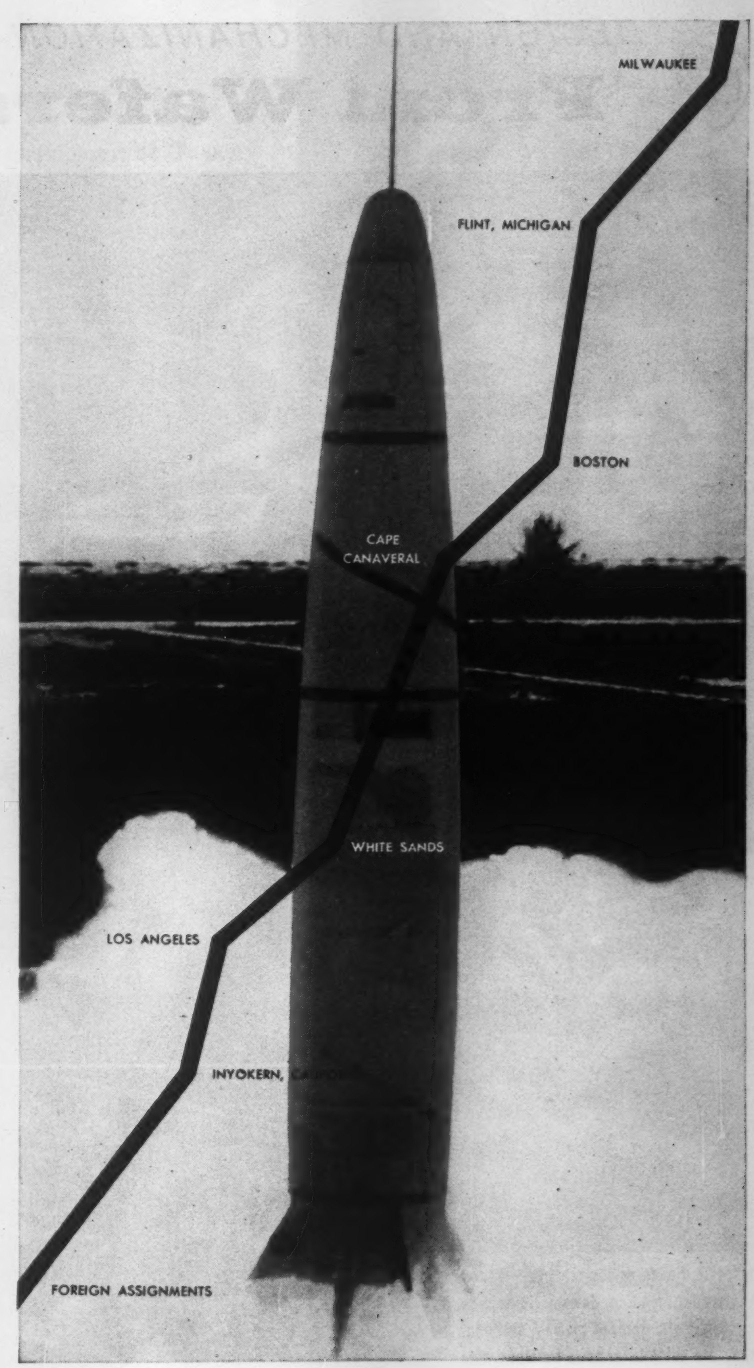
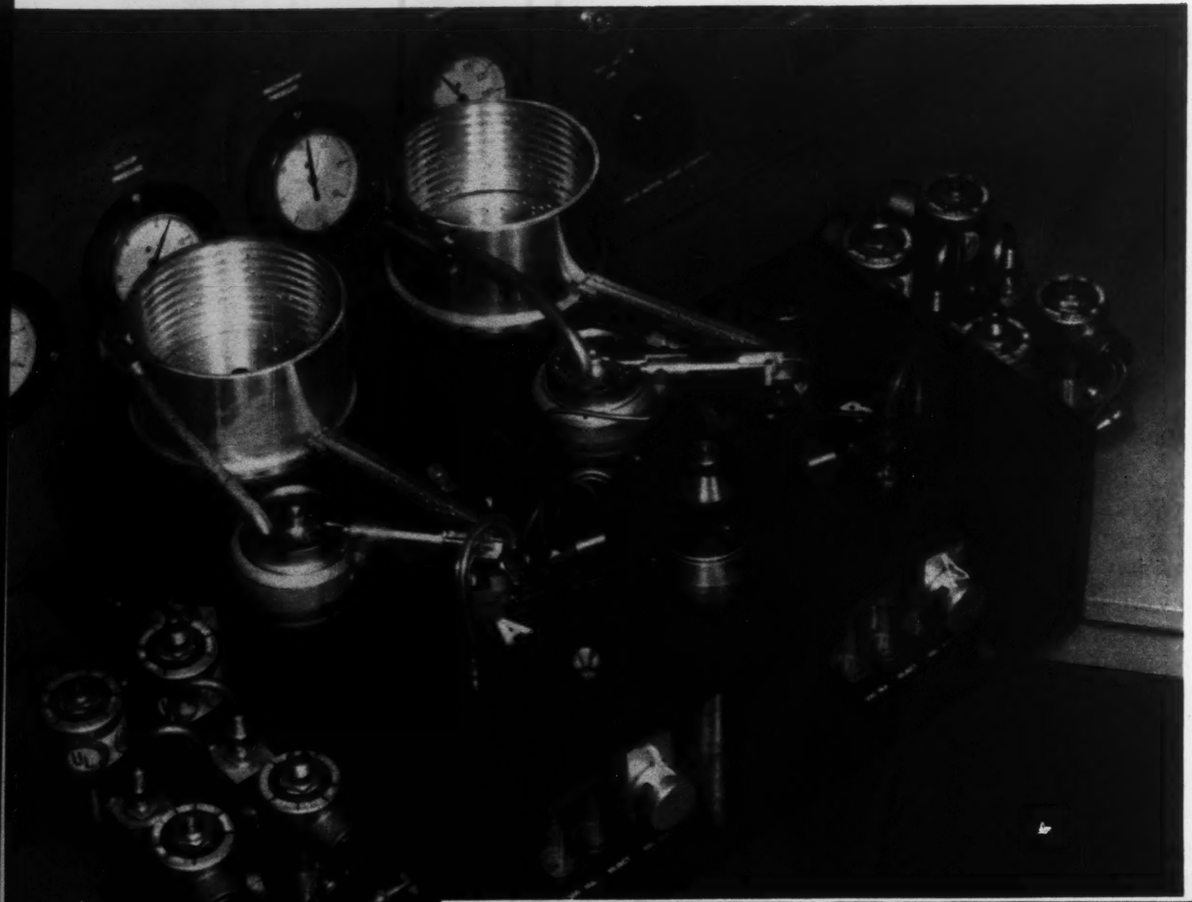


The Thor, launched on a cushion of flames, is guided by the AChiever. And the AChiever does its job so well that the demand for AC products is constantly increasing.

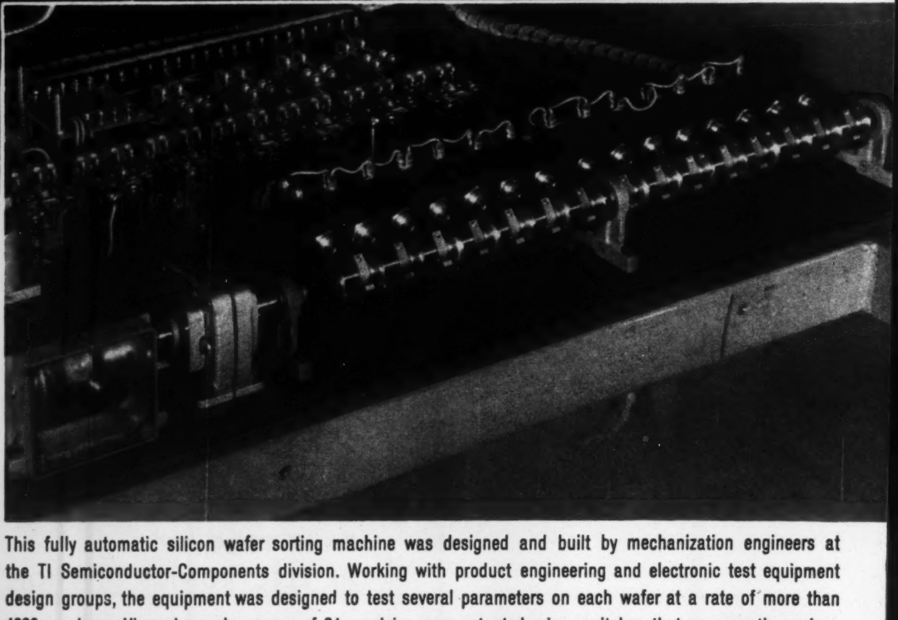
AC SPARK PLUG
THE ELECTRONICS DIVISION OF GENERAL MOTORS

DESIGN AND MECHANIZATION OPPORTUNITIES . . .

From Wafers to Wave

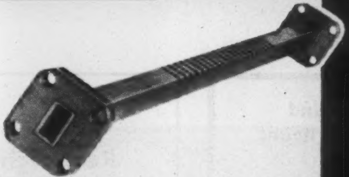


Wafers for TI diodes or rectifiers are loaded in the vibrating feeding devices, that pass them through synchronized pick-up stations. Here they are vacuum gripped between sets of test points at either end of an oscillating arm, and electrical tests of several parameters on each wafer are performed during transit to the discharge area. Results of the tests trip the proper trap door allowing the wafer to fall into the right stock vial.



This fully automatic silicon wafer sorting machine was designed and built by mechanization engineers at the TI Semiconductor-Components division. Working with product engineering and electronic test equipment design groups, the equipment was designed to test several parameters on each wafer at a rate of more than 4000 per hour. View above shows row of 24 precision cam-actuated micro-switches that program the various vacuum, pneumatic and electrical operating functions during each cycle.

Guides



Ever-increasing demands of Space Age technology at Texas Instruments have created permanent professional openings for gifted Mechanical Engineers. Opportunities in the Semiconductor-Components and Apparatus divisions vary widely in the fields of engineering design and production line mechanization. ME's at TI find substantial design freedom to immunize systems and components against heat, cold, vibration, shock, and reliability pitfalls in this engineer-managed 29-year old company.

Take a recognized part in the planned steady growth of dynamic Texas Instruments. In the last year alone, the Apparatus division more than doubled its plant size and the Semiconductor-Components division opened the world's largest semiconductor facility (over seven acres under one roof) and began construction on a four-acre addition. Texas Instruments annual sales rate during the past ten years has grown 18-fold to $91 million in 1958 and the total number of TI'ers has increased nine times during the same period to nearly 8000.

Texas Instruments Apparatus and Semiconductor-Components division plants are located in Dallas but away from downtown traffic, near excellent residential areas with highly rated schools and fine shopping centers. At TI you will live just minutes away from work . . . in the entertainment, cultural, recreational and electronics capital of the Southwest. Up-to-date personnel benefits include company-sponsored profit-sharing, educational assistance, semi-annual salary reviews, insurance, and retirement programs.

Semiconductor-Components division

Mechanical Engineers with one to 10 years experience, including those who have worked in semiconductor or vacuum tube activities, and who have designed manufacturing and prototype equipment. This equipment includes complex high-speed, automatic and semi-automatic machines ranging through miniature rotating, actuating and sensing devices; gyro and servo mechanisms; relays, thermosensors and micro-miniature devices.

Please write H. C. Laur
Semiconductor-Components division;
Dept. 2807

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Mechanical Engineers with three to 10 years experience related to the following fields are invited to discuss your qualifications in confidence: antenna design — electronics equipment — precision mechanism design — miniaturization — thermodynamic design — refrigeration and insulation — electronics packaging — structural design — tooling design and manufacturing engineering.

Please write J. R. Pinkston
Apparatus division;
Dept. 2807

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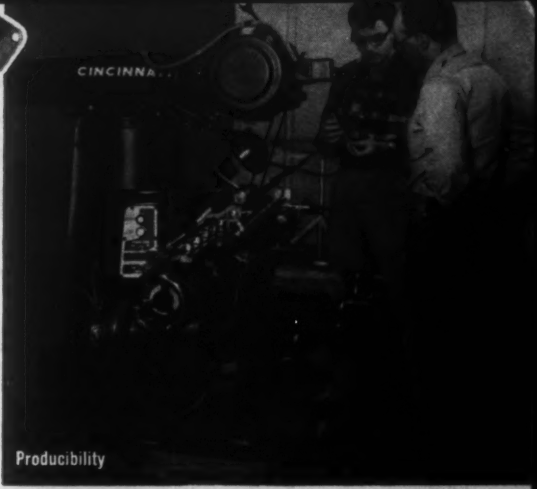
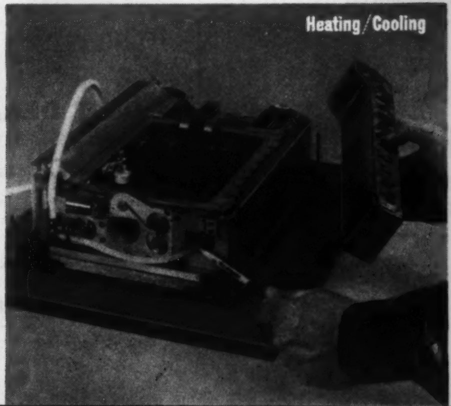


Reliability



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Mechanical Engineers

For Nuclear Power Engineering Department

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Nuclear experience is desirable but, for most of these positions, not essential.

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SOUTHWEST RESEARCH INSTITUTE
8500 Culebra Road
San Antonio 6, Texas

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Write for E.S.P.S. weekly Bulletin of Positions Available. . . See a partial listing of available positions in Personnel Section.

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Professional Personnel Requisition

Controls & Instrumentation Engineers

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To create components for pneumatic and hydraulic control systems. Work ranges from simple piston actuators to complex speed computing devices. All designed for high sensitivity, fast response, extreme environmental conditions and light weight. Should be experienced in machine design and have an understanding of basic design analysis.

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CONTROLS DEVELOPMENT

Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

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Implement, establish and/or originate the use of standards both design and hardware for reduction of time and cost of engineering effort. Must have knowledge of hydraulic and pneumatic design and components. Should be capable of setting up an evaluation program as required. Requires ability to work with many engineering groups both in advisory and service capacity.

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To predict reliability of control of units and recommend appropriate design changes. Knowledge of servomechanisms and feedback theory desirable. Should have background in statistics and experience in reliability field.

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Specification and design of instrument components and systems for ground testing of supersonic ramjet engines, jet engine components, inlet controls, nuclear powerplant controls and emergency power units. Prefer instrumentation experience, including data acquisition and processing equipment. Familiar with process control systems.

For additional information, please write
Mr. Floyd E. Hargiss, Manager
Professional Personnel, Dept. K-1
Marquardt Aircraft Co.
16555 Saticoy Street
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*(*formerly Aircraft Gas Turbine Division, recently renamed to match its expanding product goals)*

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...and many others.
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For further information on the opportunities that will let you use your talents better, send your resume to Mr. Mark Peters, Bldg. 100, Dept. 41-ME.

FLIGHT PROPULSION DIVISION

GENERAL ELECTRIC

Cincinnati, Ohio

SENIOR RESEARCH SPECIALISTS

A leading engineering organization with world-wide operations has established and is expanding a long-range program of research and development in physical science and applied mechanics to supplement its existing programs in the design and construction of petroleum, chemical and metallurgical plants.

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Fundamental and development studies on problems of iron ore reduction and beneficiation.

For top notch PhD or MS research specialists with 5 to 10 years' experience, positions offer an unusually high degree of professional recognition, freedom for original work, technical and financial growth.

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full details in confidence
to R. L. Slacom.

The
M. W. KELLOGG
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Engineer with B.S. degree and industrial experience wanted by leading manufacturer of hydraulic equipment, located in Northern California. Duties will consist of design and development of all types of centrifugal pumps. Outstanding career opportunity for right man. Good starting salary. Many company benefits. Write to

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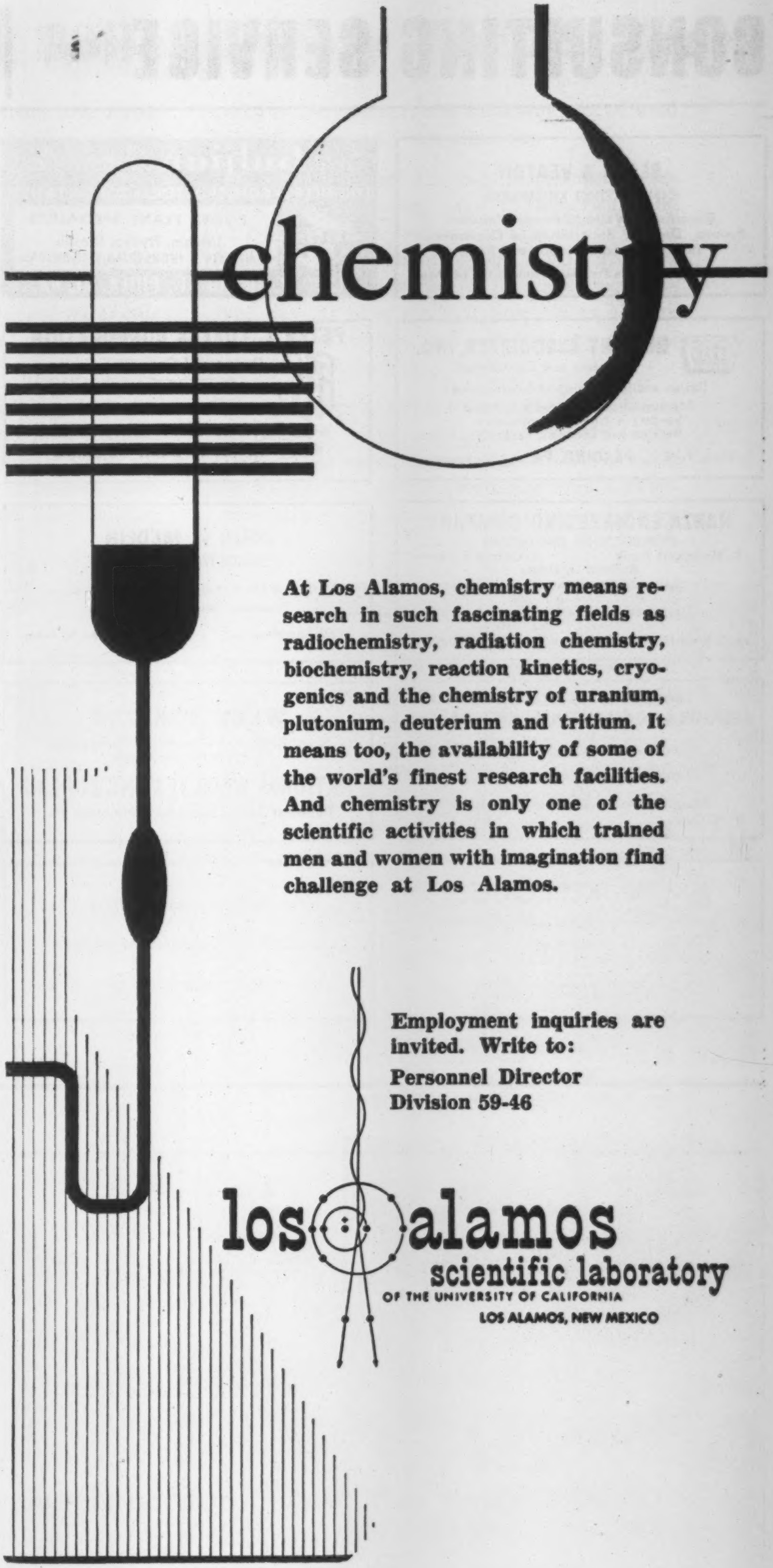

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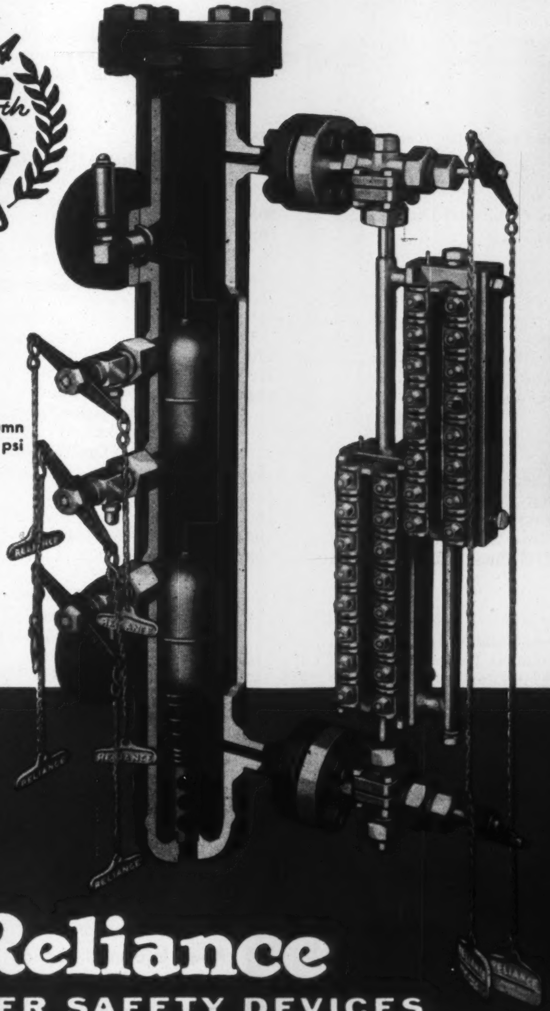

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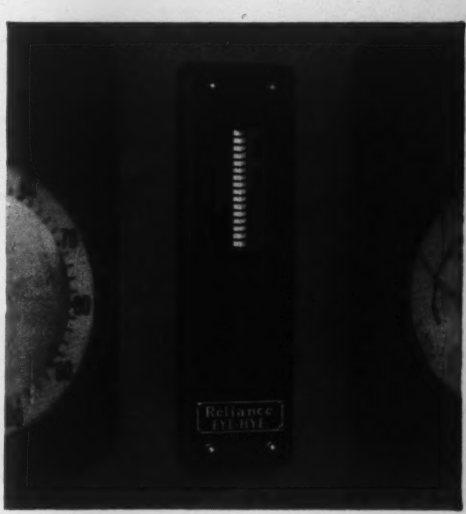
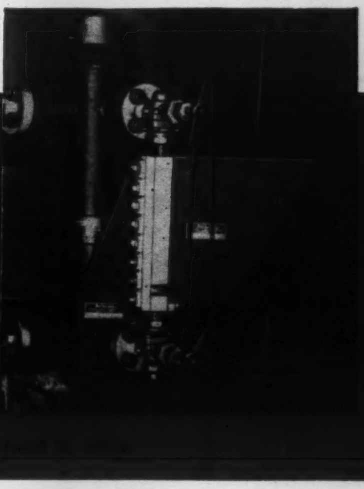


Above — newly styled EYE-HYE remote gage readable up to 90° either side of center.



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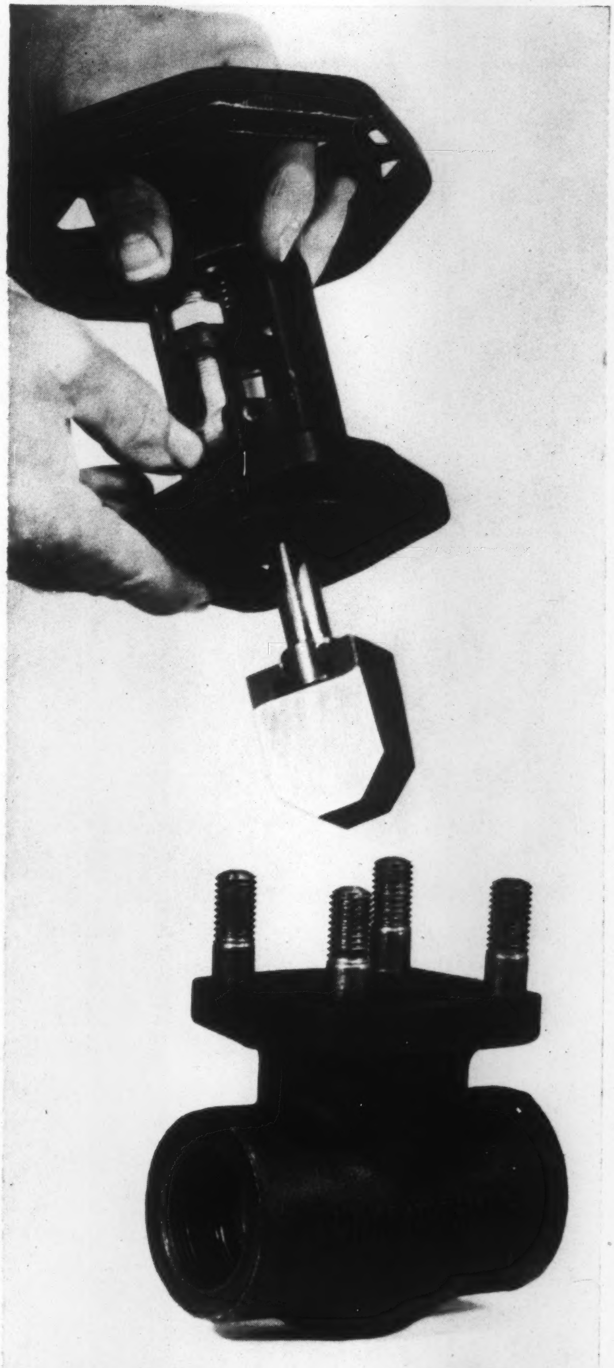

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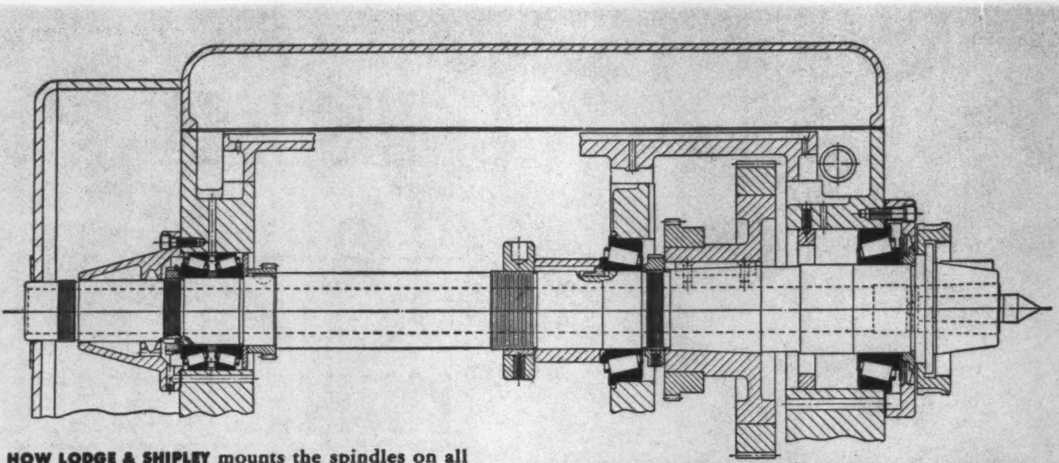

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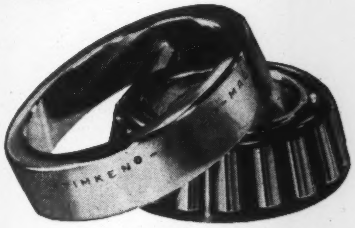

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